2014

# Beyond academic preparation: Anticipatory socialization, values, and the experiences of undergraduate male African American engineering students

Jacob David Joseph
*William & Mary - School of Education*

# BEYOND ACADEMIC PREPARATION: ANTICIPATORY SOCIALIZATION, VALUES, AND THE EXPERIENCES OF UNDERGRADUATE MALE AFRICAN AMERICAN ENGINEERING STUDENTS

---

A Dissertation

Presented to:

The Faculty of the School of Education

The College of William & Mary

---

In Partial Fulfillment

Of the Requirements for the Degree

Doctor of Philosophy

---

by

Jacob David Joseph

October 2014

**BEYOND ACADEMIC PREPARATION:**
**ANTICIPATORY SOCIALIZATION, VALUES, AND THE EXPERIENCES OF AFRICAN AMERICAN MALE ENGINEERING STUDENTS**

By

Jacob D. Joseph

---

Approved October, 2014 by

Jamel K. Donnor, Ph.D.
Chairperson of Doctoral Committee
The College of William and Mary

Pamela L. Eddy, Ph. D.
The College of William and Mary

James P. Barber, Ph.D.
The College of William and Mary

## Table of Contents

**Acknowledgments**

I would like to provide thanks to all who assisted through my journey. In particular, I would like to thank my chair, Dr. Jamel Donnor. Without Dr. Donnor's editing and support, my prose would be dry, difficult to read, and uninspiring. Dr. Donnor's commitment to my success has been evident throughout all he has done for me and my work. I would like to thank Dr. Pamela Eddy for her continual interest in my study and the support she gave to me throughout. I would also like to thank Dr. James Barber for his thoughtful critique of my theoretical framework and his suggestions regarding the incorporation of additional scholarly work providing rationale for the importance of college communities. My wife, Anne Joseph, deserves thanks for her tireless editing and patience with my many nights and weekends away from home spent with participants. Finally, I would like to thank Daryl Sklar, without whom I would not be here today. About two semesters into this journey, when I was ready to quit, he encouraged me to continue, because, as he said, "Because I always wanted to call you Dr. Jake."

## List of Tables

## List of Figures

**Abstract**

Policymakers and the public have called for science, technology, engineering, and mathematics (STEM) educational improvements to increase the number of practicing scientists and engineers in the United States. In addition to an overall shortage of STEM workers, African Americans tend to be underrepresented in these fields. In part, this racial disparity is caused by a lack of African Americans choosing to pursue degrees in STEM fields. However, African American students depart engineering studies at rates higher than their White and Asian counterparts, further decreasing racial diversity in the field of engineering.

The purpose of this dissertation study was to qualitatively examine the pre-collegiate experiences of African American male engineering students to determine differences in anticipatory socialization between those students who departed from engineering and those who chose to stay. An analysis of interviews with both departing and staying students found that participants felt their high school experience failed to prepare them for the engineering school environment in terms of rigor, team-work, and the ability and desire to seek academic assistance. In addition, this study found that students received most of their actionable advice about college from siblings, as opposed to parents. Finally, participants indicated the importance of summer bridge programs to prepare students for the collegiate engineering environment. The findings of this dissertation study support changes to the high school curriculum and increased access for students to summer bridge programs to improve the retention of African American male engineering students.

*Keywords:* engineering, departure, African American, anticipatory socialization, STEM

# BEYOND ACADEMIC PREPARATION: ANTICIPATORY SOCIALIZATION, VALUES, AND THE EXPERIENCES OF UNDERGRADUATE MALE AFRICAN AMERICAN ENGINEERING STUDENTS

**Jacob D. Joseph**

**The College of William and Mary**

## Chapter One: Introduction

Policymakers, the media, and the public have focused a significant amount of attention on the purported decline in the dominance of the United States in the fields of science, technology, engineering, and mathematics (STEM) (Atkinson, 2012; Epstein & Miller, 2011; Johnson, 2012; National Academy of Sciences, 2007; Riley, 2013). The response to the perceived deficiency has been similar to the reform efforts in science education precipitated by the Soviet launch of the Sputnik satellite in October of 1957 (Rutherford, 1998). In particular, the 2007 publication of *Rising Above the Gathering Storm* has led to intensive efforts to increase the number of domestic STEM professionals (National Academy of Sciences, 2007, 2010).

*Rising Above the Gathering Storm* argued that the United States would experience a significant shortfall in its scientific and technical human resources as the supply of both undergraduate and graduate students obtaining STEM degrees decreases and the current STEM workforce is lost through retirement (National Academy of Sciences, 2007). Moreover, the National Academy of Sciences (2007) predicted dire economic consequences for the United States, such as greatly increased unemployment and reduced quality of life, if the nation failed to address the declining number and quality of domestic STEM professionals. Prompted by these predictions, policymakers at the local, state and federal level have sought to rapidly implement K-12 educational reform, increase incentives for students to pursue higher education in the STEM disciplines, and increase involvement of business in educational efforts (Atkinson, 2012; Epstein & Miller, 2011; Johnson, 2012; Riley, 2013; Subotnik, Tai, Rickoff, & Almarode, 2010; Virginia Higher Education Act, 2011).

Although the prevailing presumption undergirding STEM policy in the United States is that the educational system is yielding an insufficient amount of STEM graduates, several critics

of this assumption have countered that a shortage does not exist (Benderly, 2012; Lowell & Salzman, 2007; National Research Council of the National Academies, 2005). Lowell and Salzman (2007) posit that the alleged mismatch between STEM graduate supply and demand is caused not by a shortage of graduates, but rather by the failure of industry demand for STEM professionals. Similarly, Benderly (2012) proposes that the technology industry has created an artificial shortage of STEM professionals in order to import talent and keep STEM professional salaries low.

Despite disagreement regarding the existence of a STEM professional shortage, policymakers and institutions continue to create programs designed to increase the numbers of students pursuing STEM degrees (National Academy of Sciences, 2010). For example, the Virginia Higher Education Opportunity Act of 2011 included provisions to increase emphasis on STEM degrees and STEM resources through private-public partnerships. Likewise, the National Defense Education Program (NDEP) provides monies to local school systems and institutions of higher education to increase the number of students pursuing STEM degrees (National Defense Education Program, 2014). The implementation of these programs is largely motivated by the projected economic consequences of insufficient numbers of STEM workers (National Academy of Sciences, 2007; National Academy of Sciences, 2010). The National Academy of Sciences (2010) predicts two economic consequences for the United States as a result of insufficient numbers of STEM professionals. The first is that the nation as a whole will suffer, as job creation is largely dependent on technological developments led by STEM professionals; the second is that if the United States fails to increase the number of STEM professionals, the quality of jobs available for individual citizens will suffer (National Academy of Sciences, 2010). That is, the pay, benefits, and resultant quality of life available for workers will decline if the United

States continues to have a deficit of STEM workers, as the effect of the new products and innovations that STEM workers bring to market have a far-ranging effect on all employment in the United States (National Academy of Sciences, 2010).

Whether or not the United States has an overall deficit of STEM workers, STEM careers are disproportionately pursued by White and Asian American males (National Center for Education Statistics, 2013). For example, African American males are underrepresented in the study of science and engineering, receiving only 8.3% of bachelor's degrees granted in science and engineering while comprising 12.6% of the general population (National Center for Education Statistics, 2013; United States Census Bureau, 2012). This underrepresentation limits the economic potential of African Americans: by not pursuing careers in STEM, African Americans limit their access to the financial benefits, such as increased pay, associated with technology-based careers (Beasley, 2011; National Academy of Sciences, 2007). Increasing the number of African Americans pursuing careers in STEM will serve to increase the economic status of African Americans as a whole, and will in turn contribute to reducing economic disparities between African Americans and Whites (Beasley, 2011). However, simply stating that African Americans need to pursue STEM careers fails to provide sufficient detail for guiding research efforts designed to increase the diversity of the STEM workforce. In particular, STEM careers are too diverse to be treated as a single concept.

**Disentangling the Acronym: STEM as a Conglomerate of Disparate Fields**

Researchers, policymakers, and the general public have treated STEM as a monolithic concept, rather than acknowledging that STEM is comprised of the individual disciplines of science, technology, engineering, and mathematics. In turn, this unitary view of STEM has led to research and proposed policy solutions that are designed to address issues across all of the

fields that comprise the acronym (Flowers, 2012; Heidel et al., 2011; Hill et al., 2011; Palmer, Maramba, & Dancy, 2011; Price, 2010; Rask, 2010). For example, in an analysis of undergraduate student attrition, Rask (2010) includes biology, chemistry, math, physics, psychology, geology, and computer science majors. These majors are substantially different from one another. Each of the majors in Rask's study has different pre-requisites, different courses of study, different resultant jobs, and different student demographic composition (National Science Foundation, Division of Science Resources Statistics, 2010; Virginia Tech, 2013).

Demographic differences among individual science and engineering fields are stark. These differences provide additional rationale for examining the disciplines that comprise STEM individually, rather than in aggregate. Examining the STEM fields in aggregate masks these demographic differences, and may contribute to erroneous conclusions. As an example of how demographic differences are masked when STEM is viewed in the aggregate, of the 473,533 science and engineering degrees conferred in 2006, approximately 49.5% were awarded to males and 50.5% were awarded to females (NSF, 2010). Although these data regarding gender distribution imply parity between men and women in the number of science and engineering degrees awarded, a closer examination shows tremendous gender disparity within individual science and engineering fields (NSF, 2010). For example, in 2006 the number of undergraduate chemistry degrees awarded was nearly at gender parity, while men were awarded nearly three times the number of undergraduate engineering degrees as women (NSF, 2010). In addition to differences in the gender distribution of students between and among certain majors, there are differences in the racial demographics associated with individual STEM fields. For example, the numbers of African Americans studying science and engineering vary widely, with African

American students representing 5.5% of the undergraduate mathematics degrees granted in 2006 and 2.4% of undergraduate astronomy degrees in the same time period (NSF, 2010). In 2011, African American students represented only 5.1% of the undergraduate population of engineering students (Engineering Workforce Commission of the American Association of Engineering Societies, Inc., 2012).

In an attempt to provide coherency and differentiation among the STEM disciplines, the research study focused solely on the engineering field, rather than examining STEM majors as a whole. The reasons for focusing on engineering as a separate entity are twofold. First, I argue that examining STEM majors in the aggregate disguises differences in the nature of the studies of science, technology, engineering, and mathematics. Secondly, by studying only engineering, this dissertation can begin to provide evidence to distinguish the differences among STEM fields from cultural and social perspectives and to provide evidence to shape policy specifically for schools of engineering to increase the diversity and numbers of their graduates.

**Increasing the Number of Engineers: Engineering Student Attrition**

As mentioned previously, STEM policy in the United States has focused on improving national economic prospects by increasing the number of practicing STEM professionals (National Academy of Sciences, 2010). That said, to increase the number of practicing STEM professionals, federal, state, and local officials have provided funding for many educational programs, reasoning that students must first have interest and ability in STEM before they can choose to pursue a career in a technical field (National Academy of Sciences, 2010). For example, K-12 STEM educational programs have been designed not only to improve student science and math scores but also to increase student interest in pursuing STEM careers (National Academy of Sciences, 2010). Additionally, higher education programs have been designed to

provide financial incentives for students to pursue careers in STEM (National Academy of Sciences, 2010). To further efforts to increase the number of students entering the STEM pipeline, higher education researchers have also sought to increase the number of STEM professionals by developing programs designed to encourage students to remain enrolled in STEM majors.

To be clear, engineering students, much like non-engineering students, leave college for a myriad of reasons (Ohland et al., 2008). Factors that contribute to engineering student attrition include: (a) insufficient student academic preparation; (b) student socialization away from engineering as a career choice; and (c) the incompatibility of the climate of the engineering school with personal identity (Bonous-Hammarth, 2000; Litzler & Young, 2012; Ohland et al., 2008).

The exact percentage of students who leave engineering programs varies depending upon the methodology used to calculate attrition rates, however, when attrition studies are examined in aggregate, approximately four out of 10 students who declare an engineering major do not graduate with an engineering degree (Litzler & Young, 2012; Ohland et al., 2008; Ohland et al., 2011). Indeed, although engineering has a reputation as having higher than average attrition rates, actual attrition rates for engineering students are among the lowest for undergraduate majors (Ohland et al., 2008). However, attrition rates vary substantially between institutions (Ohland et al., 2011). In addition, attrition rates for minorities are higher than those for White males (National Academy of Engineering, 2005; Ohland et al., 2011). Further complicating the interpretation of attrition rates, the climate and environment of an institution interacts with student demographics to affect African American STEM student attrition. That is, African American attrition rates depend heavily on sudents' choice of school. For example, Ohland and

colleagues (2011) found that attrition rates for African American students varied from 40% to 70%, depending upon the attending institution. The higher attrition rates for African American students in combination with the increased variability of African American student attrition provide much of the rationale for the focus of this study.

**Focus of Study**

As established earlier, African Americans have higher attrition rates than their White counterparts in in engineering programs and are underrepresented in the engineering profession. Given this continued disparity and the relationship between pre-collegiate experiences and college attrition, this dissertation focused on the experiences of male African American engineering students prior to college matriculation and how pre-collegiate experiences influence engineering attrition rates. To better explore this phenomenon, I will use the concept of anticipatory socialization (Merton, 1968) in conjunction with Tinto and Pusser's (2006) model for institutional action. Anticipatory socialization as a framework provides a means to examine the pre-collegiate experiences of students (Merton, 1968), while Tinto and Pusser's (2006) framework for institutional action provides a means to examine the interaction of these pre-collegiate experiences with institutional attributes.

According to Merton (1968), anticipatory socialization is "the acquisition of values and orientations found in statuses and groups in which one is not yet engaged but which one is likely to enter" (p. 438). Anticipatory socialization can be intentional, through the enrollment in formal training programs, however, "much of such preparation is implicit, unwitting, and informal" (Merton, 1968, p.439). For Merton (1968), the acquisition of values serves two purposes. First, the acquisition of values eases the transition to the new role. Second, acquiring values assists in ensuring the acceptance of the new member by the group which the role incumbent aspires to

join (Merton, 1968). In sum, the anticipatory socialization of a student can prepare him or her for acceptance in or alienate a student from collegiate socialization (Weidman, Twale, & Stein, 2001). Acceptance implies that a student will remain in a chosen course of study and alienation implies that a student will leave. Merton (1968) developed the concept of anticipatory socialization as a broad means to describe group membership, and this concept has been used to describe many social phenomena, from success in the workplace to marijuana use among college freshmen (Bess, 1978; Gibson & Papa, 2000; Mauss, 1969; Shields, 2002). As a theoretical example, students who have been anticipatorily socialized to value membership in collegiate social organizations, such as fraternities or sororities, may have an easier time developing a sense of belonging in college. I posit that using anticipatory socialization as a framework allows exploration regarding the process through which pre-collegiate experiences shape values that in turn affect elements of the student experience that contribute to attrition.

In addition to Merton's (1968) concept of anticipatory socialization, I also used Tinto and Pusser's (2006) model of college departure to provide a framework for this dissertation research. Tinto and Pusser (2006) propose that many elements of a student's experience in college, such as student involvement in campus life, contribute to student retention. Tinto and Pusser's (2006) framework provides a means to examine the values and habits present in prospective students that reduce college attrition rates that are not specifically delineated by the concept of anticipatory socialization. However, Tinto and Pusser's (2006) framework does not specifically detail how or why pre-collegiate experiences affect college attrition.

To address which aspects of both pre-collegiate experiences and the collegiate environment contribute to engineering student attrition, I used a framework that combines the concept of anticipatory socialization (Merton, 1968) and Tinto and Pusser's (2006) model of

college departure. As an example of how these two frameworks were combined to understand the data collected for this dissertation, the study examined how a student's pre-collegiate experiences contribute to the student's choice to join campus organizations. The pre-collegiate experiences were examined through the lens of anticipatory socialization (Merton, 1968), while the campus experiences were examined through Tinto and Pusser's (2006) framework.

**Purpose of Study**

The purpose of this study was to compare the anticipatory socialization experiences of African American male undergraduate engineering students with those of male African American students who have chosen to withdraw from the same program. I posit that by focusing on anticipatory socialization experiences this dissertation will elucidate the pre-collegiate experiences for these students that affect student retention.

I have chosen to focus specifically on male African Americans for this dissertation based on their underrepresentation in the field of engineering. Women are underrepresented in the engineering profession, and many authors have shown that women engineering students face unique challenges (e.g. Foor, Walden, Trytten, 2007; Vogt, Hocevar, & Hagedorn, 2007). However, despite these challenges, African American women graduate at a higher percentage than their male peers from engineering programs (National Center for Education Statistics, 2000; Ohland et al., 2011). In addition, women's rates of perseverance in engineering programs are more dependent on their attending institution (Ohland et al., 2011). The story of women engineering student experiences is important for the same reasons that the study of male African American student experiences is important; however, it is a different story.

**Research Question**

This dissertation was guided by the following research question: In what ways is the anticipatory socialization of male African American students who choose to remain in a collegiate engineering program different from the anticipatory socialization of male African American students who depart from these programs?

**Significance of the Study**

The findings of this study have the potential to be relevant for three reasons. First, the results of this study have the potential to illuminate the manner in which society prepares male African American students to be successful in undergraduate engineering programs.

Second, this study is significant in the choice of research methodology. Researchers infrequently use qualitative research methods to examine engineering attrition (Matusovich, Streveler, & Miller, 2010; Perna & Thomas, 2008). According to Matusovich, Streveler, and Miller (2010), "[s]urprisingly little research on persistence in engineering has been conducted from the student perspective, and even less explains how persistence happens" (p. 290). That said, this study will fill a gap in the current research literature by providing student perspectives regarding attrition. In addition, Attinasi (1989) suggests that additional qualitative research is needed to examine the relationship between engineering attrition rates and students' anticipatory socialization experiences in order to determine how society prepares students to successfully complete an undergraduate engineering degree.

Third, this dissertation is important because of its examination of male African American engineering students. African Americans are underrepresented not only in the engineering field, but also in the research performed regarding student attrition from this major (Harper, 2010; R. M. Johnson, 2000; Perna, Gasman, Gary, Lundy-Wagner, & Drezner, 2010; Rendon, Jalomo, &

Nora, 2000). Little research has been conducted to determine what makes students of color successful in engineering and what aspects of student preparation decrease African American engineering attrition rates (Harper, 2010).

## Chapter Two: Review of Literature and Theoretical Framework

This literature review will first examine statistics regarding engineering student attrition in general and male African American engineering attrition in particular. I will then examine the ways in which engineering student attrition has been defined in the literature in order to provide a foundation for the way in which this dissertation defined engineering attrition. Based on this discussion of engineering attrition rates, this chapter will then review reasons for engineering attrition that include: student ability, student preparation, the difficulty of the engineering program, and the socialization of students in the engineering program. These general causes of engineering student attrition will be examined specifically with regard to African American engineering student attrition. I will then establish the theoretical framework for this dissertation, which encompasses both the concept of anticipatory socialization (Merton, 1968) and its relation to the process of college student attrition. This dissertation will then present an overview of literature regarding anticipatory socialization and how this sociological concept has been applied to education. Next, this chapter will examine Tinto and Pusser's (2006) framework for understanding student attrition. Finally, I will combine elements of anticipatory socialization and Tinto and Pusser's model to develop a model of engineering student attrition.

### Avoiding Bias in Terminology: Is Staying in College Always "Success"?

Researchers have used various terms to describe the process through which students leave higher education (Berger & Lyon, 2005; Tinto, 1993). Students who leave are said to "drop-out," "stop-out" or "opt-out," as opposed to students who stay who are referred to as "successes" or "persisters," with all the concomitant associations that these words provide (Berger & Lyon, 2005; Tinto, 1993). In order to minimize both positive and negative associations with the terminology used to describe student departure, this dissertation will use the terms "attrition" and

"departure" to describe students choosing to leave a program of studies. The term "drop-out," in contrast to the terms attrition or departure, pejoratively defines a student who leaves an educational program, and it provides little indication as to reasons for the student's departure (Astin & Oseguera, 2005; Hagedorn, 2005; Tierney, 2000; Tinto, 1993). Therefore, to minimize bias, I have chosen to use the terms attrition and departure to describe students leaving engineering for this study.

**Engineering Attrition Rates: How Many Choose to Leave and Why it Matters**

In 2011, there were approximately 471,920 students enrolled in undergraduate engineering programs in the United States of America (Engineering Workforce Commission of the American Association of Engineering Societies, Inc., 2012). Of these students, approximately 24,226 were African American (Engineering Workforce Commission of the American Association of Engineering Societies, Inc., 2012). The population of male African American engineering students in 2011 was approximately 18,274, or 3.8% of the total undergraduate engineering enrollment (Engineering Workforce Commission of the American Association of Engineering Societies, Inc., 2012). The general population of African American males in the United States is 6.4% (United States Census Bureau, 2012). Given these figures, the enrollment of African American males in engineering underrepresents the population of students as a whole. In addition, male African American engineering students are more likely to leave their program of studies than other demographic subgroups, contributing to the underrepresentation of African Americans in engineering careers (Ohland et al., 2011). Although African American students are proportionally represented when they begin in an engineering program, their loss through attrition may contribute to the lack of diversity in the

engineering profession. African Americans comprise 12% of the United States workforce, but only 5% of practicing engineers (National Action Council for Minorities in Engineering, 2011).

Numerous study results show higher engineering attrition rates for students of color than for the general population of engineering students (Berger & Lyon, 2005; Bonous-Hammarth, 2000; Nora, Barlow, & Crisp, 2005; Ohland et al., 2011). For instance, Ohland and colleagues (2011) found African American male attrition to be 59% compared to White males at 45% and general engineering attrition rates of 43%. In addition, Bonous-Hammarth (2000) found that the attrition rate of African Americans in STEM majors was 44% as opposed to 25% for Whites in STEM. This disparity is important to note, especially when examining engineering attrition rates in aggregate.

In comparison to the attrition rates for African American students, overall, approximately 43% of students who have declared engineering as their academic major will leave before their junior year (Ohland et al., 2008; Symonds, Schwartz, & Ferguson, 2011; Zhang, Anderson, Ohland, & Thorndyke, 2004). An attrition rate of 43% compares favorably with business undergraduate degree programs, which have an attrition rate of approximately 45% (Ohland et al., 2008). Engineering attrition rates also compare favorably with other STEM disciplines. For example, 62% of students who choose to study computer science leave before their eighth semester (Ohland et al., 2008). In general, when examined as a whole population, engineering students are less likely to leave their chosen major than students who begin in other disciplines. This seems to indicate that engineering attrition in general is not necessarily problematic, and that a lack of qualified engineers may stem from insufficient enrollment in engineering programs.

Given the greater retention rates for engineering majors compared to the general college population, the study of engineering attrition may seem to lack appropriate axiology. That is, if engineering attrition rates are lower than those of the general college population, what reasons do researchers have for studying the departure of engineering students as distinct from college attrition in general? Despite engineering students leaving at levels lower than their non-engineering peers, several factors demonstrate the importance of studying engineering attrition rates distinctly from general college attrition. First, as established previously, persons of color continue to be underrepresented in the engineering profession, and reducing college attrition rates represents a means of increasing the diversity of the engineering profession (Harper, 2008; Lowell & Salzman, 2007; National Action Council for Minorities in Engineering, 2011; Perna et al., 2010). Second, the demand for qualified engineers in the United States far outstrips the supply, and reducing attrition is one way of increasing the supply of qualified domestic engineers (National Academy of Sciences, 2007; Rothwell and Ruiz, 2013). Forty-six percent of science, technology, engineering, and mathematics (STEM) jobs remain unfilled for one month or longer, as opposed to 36% of all jobs (Rothwell & Ruiz, 2013). Employers report that the hardest to fill jobs are for skilled technicians, engineers, and IT staff (Rothwell & Ruiz, 2013). Finally, increasing the supply of domestic engineers increases the economic vitality of the United States, as the majority of GDP growth in the United States can be attributed either directly or indirectly to technological advancement (National Academy of Sciences, 2007).

The economy of the United States has become increasingly technology-driven, and this increased technological focus has created additional demand for scientists and engineers (National Academy of Sciences, 2007). Employment in STEM fields is expected to grow by 29% for the period from 2010 to 2020, compared with growth of 14% for all occupations

(Bureau of Labor Statistics, 2012). The lack of a sufficient number of technology workers to fill new positions is further exacerbated by an aging workforce, as the share of technical workers over 55 years old will increase from 19.5% to 25.2% from 2010 to 2020 (National Academy of Sciences, 2007; Bureau of Labor Statistics, 2012). The United States' need for qualified engineers has fueled an increased demand for engineering graduates.

Many federal and institutional programs have been created to satisfy the increased demand for qualified engineers (Davis, Yeary, & Sluss, 2012; Griffin et al., 2010; Vogt, 2008). For example, the Meyerhoff Scholars Program at the University of Maryland Baltimore County is a prominent program designed to decrease engineering student attrition rates (University of Maryland Baltimore County, 2013a). The Meyerhoff program provides financial and social support for students through scholarships, summer bridge programs, the intentional creation of learning communities, and personalized advising (UMBC, 2013a). Since the program's inception in 1988, it has graduated over 800 students, 53% of whom have been African American (University of Maryland Baltimore County, 2013b). The Meyerhoff program has a current enrollment of over 300 students, which represents more than 10% of the undergraduate engineering student population of UMBC, and specifically attempts to recruit minority students (University of Maryland Baltimore County, 2013c). A primary component of the Meyerhoff program is a summer session, in which students are prepared for the differences between high school academics and college academics. This summer program represents UMBC's effort to socialize students to expect the difficulty of STEM studies (UMBC, 2013a). The Meyerhoff program is but one of many institutionally based programs designed to reduce attrition rates of engineering students. However, as the Meyerhoff program seeks to intentionally anticipatorily

socialize students to the rules and values associated with STEM college student retention, its success in retaining students represents a particularly salient example for this dissertation study.

**Defining Engineering Student Attrition**

Although the definition of attrition should be straightforward, several practical factors prevent the establishment of a uniform definition of engineering student attrition. As discussed previously in this dissertation, many terms are used to describe the process and outcome of a student leaving an institution of higher learning. Likewise, researchers have used many definitions of how to define whether a student has departed from their chosen major or higher education in general. Because much of the research regarding engineering attrition is concerned with increasing the number of practicing engineers, a student who begins in an engineering program, yet does not finish, should count as a student who departed. Measuring student attrition in this manner would allow researchers to determine easily the effect of programs designed to increase the number of engineers. Unfortunately, researchers have yet to establish a uniform definition of attrition (Bean, 1985; Berger & Lyon, 2005; Mortenson, 2005; Ohland et al., 2008; Ohland et al., 2011; Perna & Thomas, 2008; Seymour & Hewitt, 1997; Tinto, 1993). Primarily, these studies differ in the amount of time used to measure when an engineering student is counted as having departed and fail to provide information regarding whether the students left college entirely. The lack of a uniform definition of engineering student attrition prevents facile comparison between studies.

Further complicating the definition of engineering student attrition, in contrast to studies of college student attrition that are primarily concerned with students who leave higher education altogether, engineering attrition studies are concerned not only with students leaving higher education, but also with students who choose to leave engineering programs for a different

course of study (Ohland et al., 2008; Veenstra, Dey, & Herrin, 2009). This fundamental difference in definition creates measurement challenges, because no system exists for longitudinally tracking students as they matriculate from institution to institution and from course of study to course of study (Ohland et al., 2011; Seymour & Hewitt, 1997; Tinto, 1993). For example, an engineering student who leaves Columbia University to finish a degree in engineering at University of California Irvine would likely count as a student who departed, despite completing an engineering program. This lack of longitudinal information implies that researchers may not be able to determine students' true educational outcomes, as the data regarding a student's ultimate educational attainment do not exist. That is, a student's educational outcome may not be captured in the data typically collected by attending institutions.

Defining what constitutes engineering student attrition is difficult for many reasons beyond measurement challenges (Ohland et al., 2011). First, accurate data regarding attrition rates are difficult to obtain (Marra, Rodgers, Shen, & Bogue, 2012; Ohland et al., 2011; Tinto, 1993). Students may leave engineering programs to continue their studies elsewhere, and data regarding reenrollment is difficult to capture (French et al., 2005; Mortenson, 2005; Tinto, 1993). Second, enrollment data is often incomplete and inaccurate (Mortenson, 2005; Tinto, 1993). Colleges and researchers have no uniform means of measuring attrition, so attrition data that colleges collect may not be meaningful when used to compare institutions (Hagedorn, 2005; Mortenson, 2005). Finally, defining what truly constitutes attrition is problematic, as a student may leave higher education and return to complete their degree many years later (Hagedorn, 2005; Tinto, 1993). As such, an enrollment gap may occur for many reasons and does not imply that a student has chosen not to ultimately continue their education (Hagedorn, 2005; Tinto, 1993). Because of the lack of clarity regarding the reasons for attrition due to non-uniform

definitions, I propose that research regarding attrition should start with a clear definition of the phenomenon, regardless of the chosen methodology and framework. Although attrition definitions are not directly germane to the use of anticipatory socialization (Merton, 1968) and Tinto and Pusser's (2006) model, they provide a means to compare the results of this study to others in the field of attrition. In order to define attrition for this dissertation, I first examine how other studies have defined attrition.

Researchers have used a myriad of operational definitions of engineering attrition (Attinasi, 1989; Ohland et al., 2008; Ohland et al., 2011; Seymour & Hewitt, 1997). Many researchers (e.g. Lichtenstein, 2010; Ohland et al., 2008; Ohland et al., 2011; Tyson, 2011; Zhang et al., 2004) have defined engineering student attrition as students leaving an engineering program before eight semesters. Ohland and colleagues (2011) justified the choice of persistence through eight semesters to demark attrition by assuming engineering students who complete eight semesters are likely to graduate. Hong and Shull (2010) used enrollment through six semesters as an indicator of student persistence, reasoning that students are most likely to leave from engineering programs during the first two years of college, and that examining enrollment at six semesters would therefore accurately capture the majority of student departure. As a result of the differences between Hong and Shull's (2010) definition and Ohland and colleagues (2011) definition, these two studies calculate different student attrition rates and arrive at different conclusions regarding student attrition. Understanding the implications of attrition studies requires careful delineation of the attrition definitions used, because changes in the definition of attrition can result in changes in conclusions regarding the reasons for attrition (Ohland et al., 2011). For example, studies that report engineering student attrition rates at the end of eight semesters tend to underreport African American attrition rates when compared to studies that

report six year graduation rates (Ohland et al., 2011). Underreporting attrition rates may lead to spurious conclusions regarding the success of programs designed to decrease student attrition and may underestimate the attrition of African American students or any other group of students. As an example, Ohland and colleagues (2011) surmise that students who depart from engineering programs after eight semesters may be doing so as a result of financial difficulties, and, in turn, this result implies that African American students may experience greater financial difficulties than White students. Give the differences in definitions of attrition, any examination of the reasons for engineering attrition must include an explanation of how these rates were determined and defined. For the purposes of this dissertation, I will use a simple definition of attrition: students who are currently enrolled in engineering and indicate their desire to remain enrolled in engineering will count as stayers, while students who have left engineering, regardless of their time spent in engineering, will count as departed. This definition was necessitated by my research design that required interviews with students are currently enrolled in engineering programs.

**Quantitative Analysis of Engineering Attrition Rates**

The most comprehensive study of engineering attrition rates was conducted by Ohland and colleagues (2008), who found that in aggregate, 43% of students leave engineering, but not necessarily college, before their eighth semester of enrollment. In a follow up to the 2008 study, Ohland and his asscociates (2011) also found that engineering attrition rates varied widely from institution to institution. Indeed, the range of engineering attrition among institutions in this study (2011) varied from 34% to 63%. Individual colleges have engineering attrition rates from

approximately 20% (Eris et al., 2010; Hartman, 2006) to 50% (French et al., 2005)[1]. The differences in engineering attrition rates are important because they imply that differences in institutional practices result in differences in student retention rates (Ohland et al., 2011). However, Ohland and colleagues (2011) found that although institutional differences affect attrition rates, racial differences in attrition rates are more pronounced than, and interact with, institutional differences. The greater attrition rate of African American students implies that institutional programs and climates can have an effect on attrition rates, but regardless of the institution, African American students have certain unique experiences that contribute to attrition. Unfortunately, there are few large scale studies of engineering attrition rates that are disaggregated by race, complicating the understanding of why African Americans are more likely to depart from engineering programs (Lord et al., 2009).

Quantitative studies designed to measure the attrition rates of students of color compared to White students have mixed results, with some studies showing comparable attrition rates for Whites and persons of color, and other studies showing vastly different rates of attrition based on race (Cabrera et al., 2005; Ohland et al., 2008). Some of the differences in reported attrition rates between Whites and persons of color can be attributed to the different persistence measures used among studies (Ohland et al., 2011). For instance, Ohland and colleagues (2011) found that measuring attrition at the eighth semester versus six year graduation rates resulted in an increase in attrition for African American males from 41% to 59%[2]. In addition to differences in apparent

---

1 Ohland et al. (2011) as well as Eris et al. (2012) purposefully do not identify the demographics of the individual schools in order to protect the anonymity of the schools. This anonymity prevents identifying concrete differences between institutional attrition rates; for example, it is difficult to say whether larger schools have higher attrition rates than smaller schools.

2 Eighth semester retention and six-year graduation rate are the specific units of measurement used in Ohland et al.'s work, making it difficult to compare results.

attrition rates caused by differing definitions of attrition, individual institutions have highly variable rates of attrition for African American engineering students. Ohland and associates (2011) report a range of attrition for African American engineering undergraduate students from 40% to 70%, but indicate that although qualitative differences are likely between student experiences, the nature of their research does not allow "inferences about the cause of these differences due to confidentiality and the relatively small number of participating institutions" (p. 238). The lack of qualitative detail in Ohland and associates' (2011) work provides impetus for research on institutional qualities that may contribute to student attrition.

An analysis of the reasons for student attrition should include consideration of gender, race, and institution, because the interaction between and among all of these variables is complex (Beasley, 2011; Lord et al., 2009; Villapando & Solorzano, 2005). Indeed, while all engineering students, regardless of race, gender, or institution, share certain experiences, ultimately, an individual's experience in an engineering program is unique (Beasley, 2011; Felder & Brent, 2005; Foor et al., 2007; McGee & Martin, 2011; Moore, Madison-Colemore, & Smith, 2003). Examining engineering attrition rates in aggregate, that is, without consideration of differences in programs between institutions and the demographics of people within these programs, does not provide the level of understanding necessary to make programmatic changes in engineering programs that will decrease student attrition rates (Li, Swaminathan, & Tang, 2009; McGee & Martin, 2011). My study sought to address this gap.

**Proposed Reasons for Engineering Attrition**

Engineering student attrition is affected by many variables. Student preparation, both academically and socially, affects the ability of students to persist in engineering (Aitken, 1982; Besterfield-Sacre, 2001; Ohland et al., 2008; Seymour & Hewitt, 1997; Tinto & Pusser, 2006;

Tinto, 1993). In addition, students need peer support to develop the sense of community necessary to persist in an engineering program (Astin & Oseguera, 2005; Bean, 1985; Beasley, 2011; Foor et al., 2007; Harper, 2006; Harper, 2010; Hausmann , Schofield, & Woods, 2007; Hurtad, Newman, Tran, & Chang, 2010; Karen & Dougherty, 2005; Moore et al., 2003; Saenz, Marcoulides, Junn, & Young, 1999; Seymour & Hewitt, 1997). Finally, students must have personal values congruent with their eventual career to remain in engineering (Beasley, 2011; Espinosa, 2011; Hutchison, Follman, Sumpter, & Bodner, 2006).

**The effects of student academic preparation on engineering student attrition.** The ability of students to complete engineering coursework, and therefore an engineering degree, is influenced by two factors: student ability and program difficulty (Aitken, 1982; Besterfield-Sacre, 2001; Ohland et al., 2008; Seymour & Hewitt, 1997). To operationalize the concept of student ability, researchers have used standardized test scores, high school grade point average (GPA), or both (Aitken, 1982; Chimka & Wang, 2009; Zhang et al., 2004). Generally, higher student standardized test scores indicate the increased likelihood of undergraduate engineering student persistence (Aitken, 1982; Chimka & Wang, 2009; Hartman, 2006; Zhang et al., 2004). In particular, higher student scores on the math portion of the SAT were associated with an increased likelihood of persistence (Chimka & Wang, 2009). The ability of standardized test score and high school GPA to predict the attrition rates of African American students is unclear (Chimka & Wang, 2009; Zhang et al., 2004). Zhang and colleagues (2004) conclude that although there are some effects associated with student demographics, they are small compared to the effect of GPA and SAT scores. Zhang and colleagues' (2004) work implies that a White student and an African American student with similar SAT scores and GPAs would likely have similar educational outcomes. Chimka and Wang (2009) indicate the need for additional

analysis to understand the influence of the interaction of student race and SAT scores on engineering student attrition rates. Given that these proxies for academic preparation fail to accurately predict attrition rates for African American students in engineering programs, I propose that academic preparation must be considered in conjunction with social preparation to understand the reasons for student attrition. Students are prepared for college life not only academically, but also through socialization; therefore, any analysis of attrition must include an examination of social as well as academic preparation.

**The effects of socialization on engineering student attrition.** Socialization plays an important role in the retention of engineering students in that it impacts the sense of community or belonging students experience in an engineering program (Seymour, 1999; Seymour & Hewitt, 1997; Tinto & Pusser, 2006; Tinto, 1993). In addition, a student's sense of community is increased by the involvement of the student within the academic and social life of the attending institution (Amelink & Creamer, 2010; Beasley, 2011; Hausmann et al., 2007; Tinto & Pusser, 2006; Tinto, 1993). For example, students who feel a connection with other people on campus are more likely to feel a sense of belonging (Tinto & Pusser, 2006). This sense of belonging stems from connections among students through social interaction on campus (Tinto & Pusser, 2006). Finding a sense of community may be particularly difficult for students of color in engineering programs as the disproportionately low numbers of students in these programs makes finding community difficult (Beasley, 2011; McGee & Martin, 2011;Seymour & Hewitt, 1997).

One factor that prevents engineering students from forming a sense of community or belonging is the "weeding-out" process, through which students are discouraged from persisting in a major (Epstein, 2006; Fries-Britt, Younger, & Hall, 2010; Laden, Milem & Crowson, 2000;

Marra et al., 2009; Seymour, 1999; Seymour & Hewitt, 1997). Engineering faculty weed out students by sending messages that indicate that academic programs are designed to allow only a certain number of students to persist and that the worth of the program is related to the low numbers of students who persist (Epstein, 2006; Hutchison-Green, Follman, & Bodner, 2008; Laden et al., 2000; Perna et al., 2010). For example, engineering students frequently state that one of the first messages that they receive from their professors involves a dismal completion rate for engineering students (Seymour & Hewitt, 1997). These messages of inadequacy may be specifically directed at students of color or amplified in their effect for students of color (McGee & Martin, 2011). For example, students of color indicate that engineering professors frequently indicate surprise at the presence of an African American student in the engineering classroom (McGee & Martin, 2011). In addition to direct messages of inadequacy, institutions weed out students through increased course-load for freshmen and sophomores (Seymour& Hewitt, 1997). For example, students are frequently advised by the engineering department to take additional courses as freshmen, and this increased course load in turn results in poor performance (Seymour & Hewitt, 1997). Without peer support, the workload and constant messages of inadequacy can overwhelm students and contribute to student attrition.

**Peer support.** While the weeding-out process can reduce a student's sense of belonging, peer support contributes to a sense of belonging (Astrin, 1984; Astin & Oseguera, 2005; Bean, 1985; Beasley, 2011; Foor et al., 2007; Harper, 2006; Harper, 2010; Hausmann et al., 2007; Hurtado et al., 2010; Karen & Dougherty, 2005; Moore et al., 2003; Saenz, Marcoulides, Junn, & Young, 1999; Seymour & Hewitt, 1997). Peer support is particularly important for students of color to be able to develop a sense of belonging (Beasley, 2011; Harper, 2006; Harper 2010; McGee & Martin, 2011). Engineering programs typically foster competition between and among

students, which can inhibit the formation of community (Hurtado et al., 2010; Seymour & Hewitt, 1997). The volume of work associated with obtaining an engineering degree also contributes to engineering students' inability to realize a sense of community (Foor et al., 2007; Hurtado et al., 2010; Seymour & Hewitt, 1997). Engineering students feel that the volume of work required to succeed in their major is greater than that of their non-engineering peers (Foor et al., 2007; Hartman, 2006; Seymour & Hewitt, 1997). As a result of the engineering student's perceived additional workload, engineering students may feel as if they are missing out on the non-academic social aspects of college life, which in turn causes a lack of integration with the college community (Foor et al., 2007; Hartman, 2006; Seymour & Hewitt, 1997). This lack of student integration within the college community is a primary reason for student departure (Astin, 1984; Espinosa, 2011; Tinto & Pusser, 2006).

Students' sense of community within an engineering program is often impacted by the degree to which their values are congruenet with the engineering program's values (Beasley, 2011; Espinosa, 2011; Hutchison et al., 2006). Students must identify with the values of fellow engineering students and the engineering program as a whole in order to develop a sense of belonging in their major; that is, students must feel that the study of engineering is a good fit for them culturally and personally (Hutchison et al., 2006; Marra et al., 2009; Walden & Foor, 2008). For example, engineering programs encourage competition between students, and students may have to value competition over cooperation in order to succeed within an engineering program (Seymour & Hewitt, 1997). Competition can further alienate students of color who are already marginalized by their limited numbers (Hurtado, Cabrera, Lin, Arellano, & Espinosa, 2009). This marginalization can be prevented by students developing a sense of community through peer support.

**Engineering student value congruence.** In addition to having personal values that are congruent with being an engineering student, a student's personal values must be congruent with the values associated with becoming an engineer (Beasley, 2011; Cech, Rubineau, Silbey, & Seron, 2011; Espinosa, 2011; Grandy, 1998; Hellman & Harbeck, 1997; Lucas, 2011). That is, students must think of a career in engineering as valuable, either personally or to the community (Beasley, 2011). Students develop ideas about the value of careers through socialization within the engineering program as well as anticipatory socialization prior to enrollment (Cech et al., 2011; Weidman et al., 2001). If students do not see their career as valuable, this will alienate them from fellow engineering students, and will therefore lead to increased attrition (Walden & Foor, 2008). This lack of perceived career value may impact African American students more than White students, as engineering is not seen by African Americans as a career that directly impacts the wellbeing of the community (Beasley, 2010).

In addition to incongruence between values associated with engineering programs and student values, student instructional expectations are often incongruent with the way engineering classes are taught (Epstein, 2006; Froyd & Ohland, 2005; Seymour & Hewitt, 1997). For example, introductory engineering classes are often taught without reference to practical application of course content (Epstein, 2006; Felder & Brent, 2005). As a result of this lack of practical application, students may not be able to determine how their eventual career will be congruent with the values they associate with that career (Froyd & Ohland 2005; Seymour & Hewitt, 1997). If students do not understand how their knowledge can be applied, this can lead to further alienation from the engineering program and increase the likelihood of student attrition (Seymour & Hewitt, 1997).

Finally, many engineering students face value conflict over their ability to finance their education (Seymour & Hewitt, 1997; Wilson, Iyengar, Pang, Warner, & Luces, 2012). Financing an engineering education may be particularly difficult because of the relatively large workload of engineering students (Hong & Shull, 2010; Lichtenstein, 2010). The academic workload of engineering students may prevent them from holding part-time jobs necessary to pay for school (Seymour & Hewitt, 1996). The effect of a lack of financial resources is complicated beyond the simple matter of paying for education. Students must weigh the value of their social integration and academic integration against the need to minimize the future and current financial burden on themselves and their families (Braxton & Hirschy, 2005; Hurtado et al., 2010). These effects of financial concerns on attrition are felt disproportionately by students of color (Hurtado et al., 2010).

Students leave engineering for many reasons. Students can feel that their values are incompatible with the manner in which the classes are taught, the culture of the school, and the probable career resultant from their course of studies. Students can fail to find fit within the engineering student community. Although the numerous mathematical models proposed to explain engineering student attrition can be used to design new ways of increasing student retention, ultimately, the experience of each student in a program is unique. The complexity of attrition demands an expansion of the research to incorporate a qualitative approach that concerns itself with the experiences of individual students.

**African American Engineering Student Attrition**

The experience of students enrolled in higher education is unique (Felder & Brent, 2005; Moore et al., 2003). The experiences of the African American students enrolled in engineering programs are especially unique (Felder & Brent, 2005; Moore et al., 2003). For example,

McGee and Martin (2011) found that African American engineering students were likely to experience prejudicial behavior in the form of professors questioning their ability to succeed in an engineering program. As a result, students enrolled in these hostile environments felt the need to continually prove themselves in a manner not experienced by the White students in the class (McGee & Martin, 2011). Overall, the literature presents three main themes regarding African American attrition from engineering programs: (a) the importance of peers to prevent student attrition; (b) the conflict of personal values associated with an eventual career in engineering; and (c) incongruence between instructional expectations and the way that courses are taught in engineering programs.

**Peer support for African American students: Building a sense of community through membership.** Supportive peer groups contribute in many ways to African American student persistence in any college major (Beasley, 2011; Harper, 2006; Hurtado & Carter, 1997; Hurtado et al., 2010; Whitla, Howard, Tuitt, Reddick, & Flanagan, 2005). Membership in peer groups increases a student's sense of belonging and commitment to the institution and the major (Beasley, 2011; Seymour & Hewitt, 1997). Engineering peer interaction provides students with connections to internships, scholarships and other financial supports that enable them to remain in engineering (Beasley, 2011). Peers provide not only social support, but also academic support such as study groups and peer tutoring (Beasley, 2011; Whitla et al., 2005). Peer support also provides a means for students of color to insulate themselves from stereotyping and racial prejudice regarding their ability to succeed in engineering programs (McGee & Martin, 2011). An adverse climate can exist for students of color enrolled in engineering programs, with students of color receiving discriminatory messages regarding their ability and worth from fellow engineering students and faculty (Beasley, 2011; McGee & Martin, 2011; Seymour & Hewitt,

1997). For example, McGee and Martin (2011) found that White engineering professors questioned African American students as to whether they were in the correct class, implying that the presence of an African American in an engineering class was a mistake. Peer support provides a positive reference group for African American students to cope with exclusionary practices in the classroom (McGee & Martin, 2011). Finally, Harper (2010) postulates that the formation of peer groups allows African American students to connect with other high achieving students to develop a supportive community that increases a student's sense of belonging.

**Contributing to the community: Professional versus personal values.** Students of color can also experience incongruence between their personal values and values associated with a career in engineering (Beasley, 2011; Cech et al., 2011; Froyd & Ohland, 2005; Seymour & Hewitt, 1997). In particular, African American students often experience value conflicts between the desire to support family and community and the work demands of the engineering program (Beasley, 2011; Seymour & Hewitt, 1997). In addition, African American students place a higher value on those careers that provide a direct contribution to their community, such as physician or lawyer, than on careers such as engineering (Beasley, 2011; Grandy, 1998). This discrepancy of values between possible careers eases the transition of student from engineering to a major more closely aligned with cultural values, such as law, medicine, or social work (Beasley, 2011). The ease of transition to a new subject may indirectly encourage students to leave the study of engineering.

In addition to incongruence between engineering program values and student values, student instructional expectations are often incongruent with the way engineering classes are taught (Froyd & Ohland, 2005; Seymour & Hewitt, 1997). Seymour and Hewitt (1997) contended that White students have been socialized to anticipate the straight lecture style of

instruction prevalent in engineering programs, whereas African American students have been socialized to expect more personalized instruction. The difference between instructional expectation and instructional reality may lead to student attrition.

**Developing the Theoretical Framework: Socialization and Institutional Influences**

I created the theoretical framework for this dissertation by combining the concepts of student socialization and institutional action. To develop this framework, I examined how socialization has been used to explain student behavior when entering the college environment. In addition, I reviewed the literature specifically concerning how educational socialization has been used to examine the experiences of engineering students. Because my dissertation includes an analysis of how pre-collegiate experiences affect student reaction to the engineering environment, and in turn how the experiences affect student attrition from engineering, I chose to examine the literature regarding the role that anticipatory socialization plays in student reactions to the college environment. In particular, I reviewed how the concept of anticipatory socialization has been applied to higher education, and the African American experience in higher education. Finally, I reviewed Tinto and Pusser's (2006) model of institutional action as a means of classifying student experiences that contribute to student decisions to leave the study of engineering. This review and theoretical framework is not designed to completely explore either the entirety of either the pre-collegiate experiences of students or the aspects of the college environment that contribute to student attrition. Rather, I created this framework to examine the differences in the pre-collegiate experiences of former and current engineering students, and how these differences relate to student decisions regarding continued enrollment in engineering. The theoretical framework is also not intended to imply that anticipatory socialization is the only means through which students can be prepared for college, but rather, to suggest that a students'

anticipatory socialization interacts with the college environment and is a contributing factor to students' decisions with regards to utilizing college resources.

**Educational socialization.** Socialization provides engineering students with tools such as language, attitudes and skills they can use to increase their chances of establishing relationships within their chosen program of studies (Merton, 1968; Weidman et al., 2001). Through socialization, the new group member gains knowledge of the unwritten social norms that define a group (Merton, 1968; Weidman et al., 2001). Unwritten social norms include acceptable and anticipated behavior in social situations, such as seeking academic help when struggling with classwork (Merton, 1968).

Understanding how socialization occurs is crucial to understanding the process through which a person acquires a new role (Thornton & Nardi, 1975). For instance, when students graduate from high school and attend college, they acquire the new role of college student. In particular, students who enter engineering programs acquire the role of engineering student. Students who successfully acquire the role of engineering student have been socialized in order to prepare them for this role. This preparatory socialization is referred to as *anticipatory socialization* (Merton, 1968).

Merton (1968) defines anticipatory socialization as "the acquisition of values and orientations found in statuses and groups in which one is not yet engaged but which one is likely to enter" (p. 438). Many sources provide anticipatory socialization to prospective engineering students (Archer et al., 2012; Attinasi, 1989; Hellman & Harbeck, 1997; Jacobs, 2005; Kamens, 1981; Krauss, 1964; Lucas, 2011; Moore et al., 2003; Thornton & Nardi, 1975; Weidman et al., 2001). Parents and siblings provide anticipatory socialization regarding the collegiate experience to prospective college students (Archer et al., 2012; Attinasi, 1989; Fries-Britt et al., 2010;

Hellman & Harbeck, 1997; Jacobs, 2005; Krauss, 1964; Lucas, 2011; Moore et al., 2003; Spady, 1970; Zurita, 2004). For example, parents may provide students with information about the value of joining social organizations on campus. Peers provide information regarding college attendance, such as which classes and majors are desirable (Attinasi, 1989; Bean, 1985; Grandy, 1998; Krauss, 1964). Teachers and the secondary educational system also provide anticipatory socialization for prospective college students (Attinasi, 1989; Grandy, 1998; Weidman, 1989). For example, teachers communicate to students which careers and colleges will be a good fit for the student (Attinasi, 1989).

Since Merton (1968) developed the concept of anticipatory socialization (Weidman et al., 2001), scholars have used it to explain numerous social phenomena (Beilin, 1956; Merton, 1968; Weidman, 1989; Weidman et al., 2001; Wilson, 1959)[3]. For example, early adopters primarily used anticipatory socialization to theorize why some individuals experience upward social mobility (Beilin, 1956; Merton, 1968; Simpson, 1962; Wilson, 1959). Merton (1968) examined the aspirations of enlisted soldiers to achieve higher ranks and found that lower ranking soldiers who adopted the social rules of higher ranking officers were more likely to rise through the ranks. Simpson (1962) found that working-class boys who made friends with middle-class boys were more likely to aspire to attain the cultural aspects of the middle class, such as pursuing a specific profession or a higher level of education. Krauss (1964) explored the influence of anticipatory socialization on the educational aspirations of students. More recently, researchers have used anticipatory socialization as a framework to explore the reasons for student departure from higher education, career choice, and ability to persist in certain jobs (Attinasi, 1989; Fries-

3 Merton's original work on anticipatory socialization took place in 1949, the 1968 date refers to the edition used for this dissertation.

Britt et al., 2010; Kamens, 1981; Perna et al., 2010; Zurita, 2004). I extended these works to use the framework of anticipatory socialization (Merton, 1968) to partially account for why African American students choose to leave engineering.

**Socialization and engineering student attrition.** Researchers have examined the role student socialization plays in the retention of science and engineering students (Athanasiou, 1971; Attinasi, 1989; Chang et al., 2008). In 1971, Robert Athanasiou theorized that socialization of students in an engineering program caused attrition by either intentionally or unintentionally accentuating differences in attitudes between students who succeed in engineering and students who change disciplines. That is, institutions purposefully create segregation within the student community to discourage students from pursuing engineering. In 2008, Chang and colleagues, in a study of biomedical and behavioral science majors, concluded that highly selective institutions "tend to further sort out students in order to identify the very best ones, often providing limited resources.... Therefore, only a few can succeed" (p. 455). Disturbingly, very little appears to have changed in the way that students are weeded-out from engineering programs in the 37 years between these studies. Perhaps even more disturbingly, the conclusions the authors draw in these studies indicate that socialization created by institutional policies, practices, and curricula contributes to student attrition (Athanasiou, 1971; Attinasi, 1989; Chang et al., 2008).

Anticipatory socialization, like other student experiences, interacts with the nature of the attending institution to affect attrition. Students view their collegiate experiences through their previous social experiences. This complicated interaction of person and institution contributes to the unique nature of the college student experience.

**Anticipatory socialization applied to post-secondary education.** Many authors have used anticipatory socialization as a means to understand aspects of post-secondary education such as student attrition and career choice (Attinasi, 1989; Bonous-Hammarth, 2000; Jacobs, 2005; Karp, 2012; Keshishian, 2010; Moore et al., 2003; Weidman, 1989; Weidman et al., 2001; Zurita, 2004). Some of these studies advocate changing aspects of student anticipatory socialization experiences in order to encourage or enable students to be successful in their new role as a college student (Attinasi, 1989; Bess, 1978; Karp, 2012; Weidman et al., 2001). Studies that focus on changing the anticipatory socialization experience for students often propose programs to intentionally socialize students to both the general college environment and the engineering environment, such as summer bridge or orientation programs (Karp, 2012). By familiarizing students with the culture, procedures, and environment of the college prior to enrollment, these programs hope to improve the transitional experience for students moving from high school to college (Karp, 2012).

The reputation and status of the attending institution anticipatorily socialize students prior to their matriculation (Alon & Tienda, 2005; Bonous-Hammarth, 2000; Chang et al., 2008). In general, students who regard the institution they choose to attend as a high-status institution tend to have a reduced rate of attrition (Alon & Tienda, 2005; Bonous-Hammarth, 2000; Chang et al., 2008). With acceptance to a school with a high perceived status, potential students may be socialized to increase their commitment to the completion of a degree, in turn reducing the chances they will depart from a program (Chang et al., 2008). Students who believe that the college has the ability to contribute to their success may be socialized to value that particular college experience and thus create a self-fulfilling prophecy for their success at that college (Perna et al., 2010).

**Anticipatory socialization and African American student attrition.** Anticipatory socialization offers a means to understand how pre-collegiate experiences affect student attrition rates (Karp, 2012; Shields, 2002). In the anticipatory socialization process, a role aspirant, i.e., a prospective college student, "takes on the values of the non-membership group to which they aspire, find[s] readier acceptance by that group and make[s] an easier adjustment to it" (Merton, 1968, p. 265). The congruency of values between the role aspirant and the sociological group creates the opportunity for successful group membership (Gibson & Papa, 2000; Merton, 1968). In order for a college student to persist in a program of studies, the student must have values congruent with the other students in the program. For example, students who do not value working on teams may find group projects difficult, and this difficulty may impact their ability to function within their peer group. In turn, a student's difficulty developing community within the engineering major may lead them to leave the study of engineering.

For this dissertation, anticipatory socialization refers to student experiences before college that contribute to a student's ability to adopt the values, beliefs, skills, and dispositions associated with successful integration into the college community (Merton, 1968; Moore et al., 2003). Students are socialized in anticipation of attending college in several ways. This socialization includes the influence of parents and family on the development of values that affect a student's fit within the college environment (Beasley, 2011; Braxton & Hirschy, 2005; Moore et al., 2003). Familial anticipatory socialization regarding career values is particularly influential for African American students for two reasons: (a) African American students are more likely to value careers such as social work that contribute directly to the community and therefore are less likely to attrit from these programs of study; and (b) African American students are more likely to value cooperation over competition, and therefore are more likely to attrit from

competitive programs such as engineering (Beasley, 2011). Likewise, secondary schools shape student values through both planned and unplanned learning experiences (Kamens, 1981). Peers also play an important role in shaping a student's values through modeling behaviors and providing access to campus resources such as social networks (Astin & Oseguera, 2005; Braxton & Hirschy, 2005; Harper, 2006). Student values and habits learned through anticipatory socialization shape student college persistence behaviors.

Anticipatory socialization is one method through which students form the values that they bring with them to the college environment. However, just as each student's experience prior to college is unique, the environment of each institution of higher learning is different. In order to understand the reasons for African American engineering student attrition, this dissertation examined not only the pre-collegiate experiences of students through anticipatory socialization, but also how these pre-collegiate experiences interact with the college environment. Understanding the student interactions within an institution that contribute to attrition requires the use of an additional framework. Tinto and Pusser's (2006) model of institutional action provides the framework with which to link the pre-collegiate anticipatory socialization experiences of the student with the environment of the institution.

**Tinto and Pusser's (2006) preliminary model of institutional action.** By using the concept of anticipatory socialization, which is concerned with pre-collegiate experiences, in conjunction with Tinto and Pusser's (2006) model of institutional action, which is concerned with student experiences in college, this dissertation examined the ways in which a student's social preparation for school interacts with the engineering school environment to contribute to or reduce student attrition. Tinto and Pusser's model is comprised of three basic elements: (a) the student experiences prior to college; (b) the commitment of the institution; and (c) the

expectational climate of the institution (See Figure 1). Through these three basic elements, Tinto and Pusser's model examines the relationship between the student, the college environment, and student departure.

Tinto and Pusser (2006) proposed that student persistence is affected by the expectational climate of the college. According to the authors, the expectational climate is the "expectations that the institution holds for student, faculty, and staff behavior" (p. 12). "Expectations" are defined as the behavioral and performance expectations for all members of the educational community (Tinto & Pusser, 2006, p.12). For example, expectations could include the expectation of the institution that professors be available to tutor struggling students (Tinto & Pusser, 2006). Colleges that hold high expectations for students and provide students with the tools to achieve these high expectations can anticipate reduced student attrition (Tinto & Pusser, 2006). Therefore, the expectational climate of an institution is highly dependent on the leadership of that institution and the culture of the university and may be the reason for differing attrition rates among institutions (Tinto & Pusser, 2006).

Tinto and Pusser (2006) distinguished three major components of institutional expectation: support, feedback, and involvement. Here, support included the financial, social, and academic support received by students. Institutions can create student social support through advising programs, supplemental instructional programs and freshman seminars (Tinto & Pusser, 2006). For example, to increase students' sense of academic and social support, colleges have also created learning communities, in which colleges intentionally link content between introductory classes (Tinto & Pusser, 2006). Finally, colleges have established peer and faculty mentoring programs in an attempt to increase students' sense of social and academic support (Harper, 2006; Seymour & Hewitt, 1997; Tinto & Pusser, 2006).

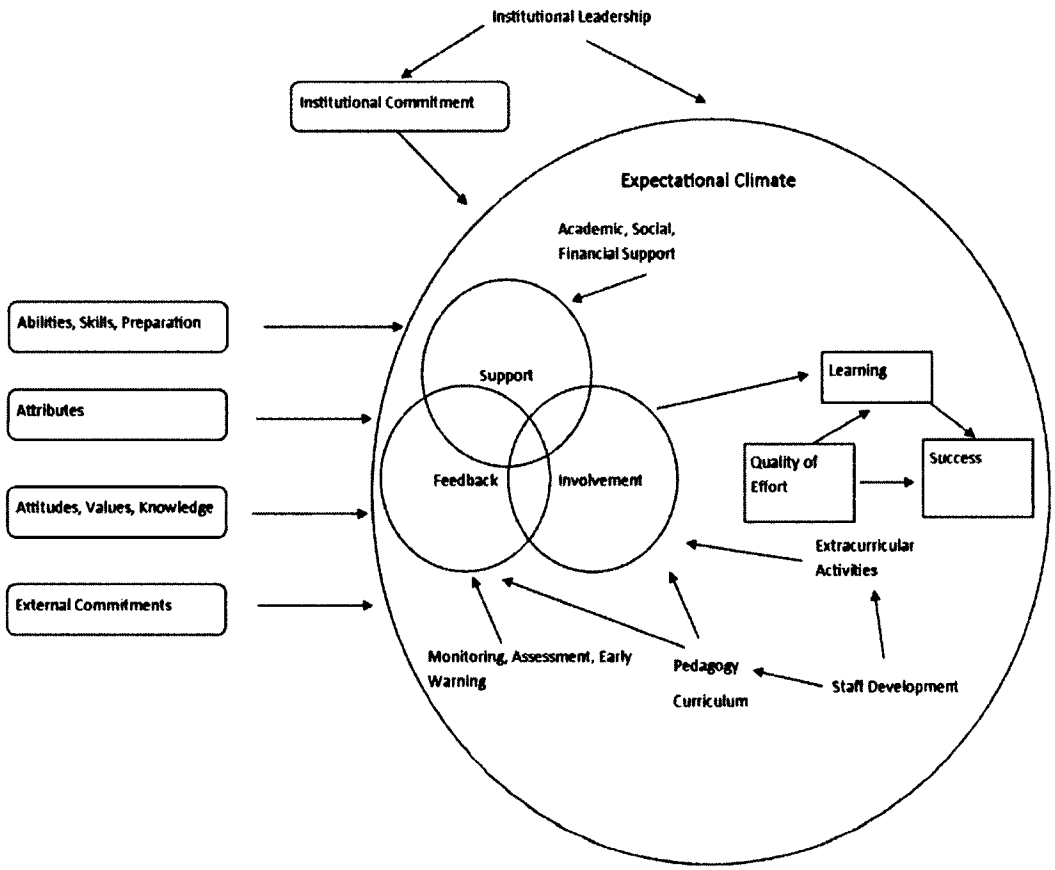


*Figure 1.* Tinto and Pusser's preliminary model for institutional success. Reproduced from Tinto, V., & Pusser, B. (2006). *Moving from theory to action: Building a model of institutional action for student success.* Washington, D.C.: National Postsecondary Education Cooperative. Used with permission of the authors.

The second component of Tinto and Pusser's (2006) model is "feedback," (p.7) which the authors use to represent student assessment. According to Tinto and Pusser, assessment can take a variety of forms. First, colleges use student assessment to ensure that students find academic coursework neither too challenging nor too repetitive (Tinto & Pusser, 2006). Among other things, matching the academic level of students to the appropriate course level contributes to reduced student attrition (Seymour & Hewitt, 1997; Tinto, 1993). In addition, colleges can use assessment information as an early warning system to provide additional interventions for students who are not succeeding academically (Tinto & Pusser, 2006). For example, colleges can establish systems through which a concerned instructor can alert a team of counselors, administrators, and instructors to intervene when a student fails to meet performance standards early in the semester (Wood, 2011).

Involvement is the third element of Tinto and Pusser's (2006) model of institutional action, referring to the sense of belonging and engagement that students feel within the college community (Tinto, 1993). Student involvement in campus life is the single largest contributing factor to student attrition rates (Tinto & Pusser, 2006; Tinto, 1993). Traditionally, colleges increase a student's sense of involvement through student membership in campus associations and other organized extra-curricular activities (Tinto & Pusser, 2006). Tinto and Pusser (2006) recognized these traditional efforts at student engagement as important, but insufficient to ensure student success. To increase the chances of student retention, the authors advocated for additional means of student engagement such as the inclusion of cooperative and collaborative learning strategies in the classroom (Tinto & Pusser, 2006).

Despite Tinto and Pusser's (2006) concentration on the role the institution plays in student attrition, the authors recognized that student attributes also contribute to attrition. In

addition, the authors confirmed that student characteristics interact with institutional practices. Institutional policies designed to increase student retention cannot be developed without consideration of student characteristics (Tinto & Pusser, 2006). For example, Tinto and Pusser (2006) indicate that school campus social activities may not be as effective in retaining non-traditional commuting students.

Tinto and Pusser's (2006) model considers four categories of student characteristics that affect student attrition rates: abilities, skills, and preparation; attributes; attitudes, values, and knowledge; and external commitments. Tinto and Pusser (2006) define student abilities, skills, and preparation as the extent to which educational and societal experiences have prepared the student academically for college. Student attributes considered by the model include socio-economic status, race, and gender. Whereas student attitudes, values, and knowledge include the "goals, commitments, motivations and expectations" (Tinto & Pusser, 2006, p. 9) that students have for college. Finally, Tinto and Pusser (2006) recognized that students often have family, employment and community commitments external to the college environment. These external commitments create tension between a student's commitment to their education and a student's commitment to family and community (Beasley, 2011; Seymour & Hewitt, 1997). To persist in their studies, students must balance the needs of their external obligations with the requirements of college life (Tinto & Pusser, 2006). For example, a student may have to choose between the requirements of a job necessary to support their family and completing their school work (Seymour & Hewitt, 1997).

Although Tinto and Pusser's (2006) model provides a framework in which elements of the pre-collegiate and collegiate experiences of students contribute to student attrition, it does not provide insight into the mechanism through which these student experiences affect student

attrition. This dissertation used the concept of anticipatory socialization (Merton, 1968) in conjunction with Tinto and Pusser's model to observe how the pre-collegiate experiences of students interact with certain collegiate experiences that have been found to contribute or reduce engineering student attrition.

Tinto and Pusser's (2006) model is appropriate to examine male African American student attrition from engineering programs for several reasons. First, it is specific to issues shaping student attrition. Second, Tinto and Pusser's model encompasses a variety of student experiences, such as those of commuting students and those of underrepresented students on majority White campuses, by taking into account the variation in policies and climate across institutions. Third, Tinto and Pusser acknowledged that although their model is focused on institutional action, schools must design retention interventions to meet specific student needs.

**Support for Tinto and Pusser's (2006) model.** Both the student and institutional aspects present in Tinto and Pusser's model are supported by a great deal of research (Astin, 1984, Braxton & Hirschy, 2005; Braxton, Vesper, & Hossler, 1995; Hurtado & Carter, 1997; Stage & Hossler, 2000). The model is largely influenced by Tinto's (1975, 1993) earlier work on student attrition from higher education. In addition, by expanding Tinto's 1975 and 1993 works, Tinto and Pusser's 2006 model addresses criticisms of Tinto's earlier models by Braxton (1995, 2000). In particular, this new model framework addresses criticisms that previous student attrition models over-emphasized the student's role while minimizing the institution's role in student retention (Braxton & Hirschy, 2005; Braxton et al., 1995; Kuh & Love, 2000).

Numerous quantitative and qualitative studies support the inclusion of student characteristics in a model of student departure (Astin & Oseguera, 2005; Bean, 1985; Berger & Lyon, 2005; Stage & Hossler, 2000). In particular, researchers have found that higher student

ability results in decreased student attrition (Aitken, 1982; Stage & Hossler, 2000). However, student demographics interact in complex ways with institutional culture to promote or discourage retention (Bean, 1985).

Research also supports the inclusion of institutional elements of Tinto and Pusser's (2006) model (Astin, 1984, Astin & Oseguera, 2005; Berger & Lyon, 2005; Perna & Thomas, 2008; Perna, Gasman, Gary, Lundy-Wagner, & Drezner, 2010). Institutions that actively promote student integration into college life are more successful at retaining students (Astin, 1984; Braxton & Hirschy, 2005; Case, 2007; Espinosa, 2011; Karen & Dougherty, 2005; Pascarella & Chapman, 1983; Walden & Foor, 2008). Early warning systems and regular student assessment also contribute to student retention (Braxton & Hirschy, 2005; Wood, 2012). Finally, research supports Tinto and Pusser's assertion that high expectations for students contribute to student success (Tierney, 2000). However, Tinto and Pusser's (2006) model is insufficient to examine the interaction between the individual and the institution. I chose to integrate Tinto and Pusser's (2006) with the concept of anticipatory socialization (Merton, 1968) to understand the roles of the individual and the institution in engineering student attrition. The focus of this dissertation study is on the interaction between student pre-collegiate experiences and the environment of the college. As such, Tinto and Pusser's (2006) model was used as a means of examining specific interactions between the student and the college, rather than a means to examine the specific college environment. Examining the interaction between the environment and the individual requires a novel model.

**A New Model to Understand African American Male Engineering Student Attrition**

Figure 2 provides a visual representation of the intersection of the effects of anticipatory socialization (Merton, 1968) and elements of Tinto and Pusser's (2006) model of institutional

action. The intersection of these two theoretical frameworks created the model that guided the research conducted in this dissertation. Each arrow in Figure 2 represents a pathway for anticipatory socialization that in part determines the manner in which a student interacts with an element of the college environment that has been shown to lead to increased student retention. For each pathway, I will briefly describe the elements of anticipatory socialization that contribute to the manner in which a student reacts to the institutional elements which contribute to and prevent student departure. This model is not meant to be all-encompassing, and does not include all elements of institutional action that contribute to student retention. In addition, the individual elements examined in this model are not meant to encompass all components potentially contained within that element. Given the complexity of the engineering departure process, I chose to focus my research efforts on the presented pathways to illuminate the areas of engineering departure processes prevalent in both literature on the engineering departure process and literature regarding the college departure process in general to answer my research question: In what ways is the anticipatory socialization of male African American students who chose to remain in a collegiate engineering program different from the anticipatory socialization of male African American students who depart from these program?

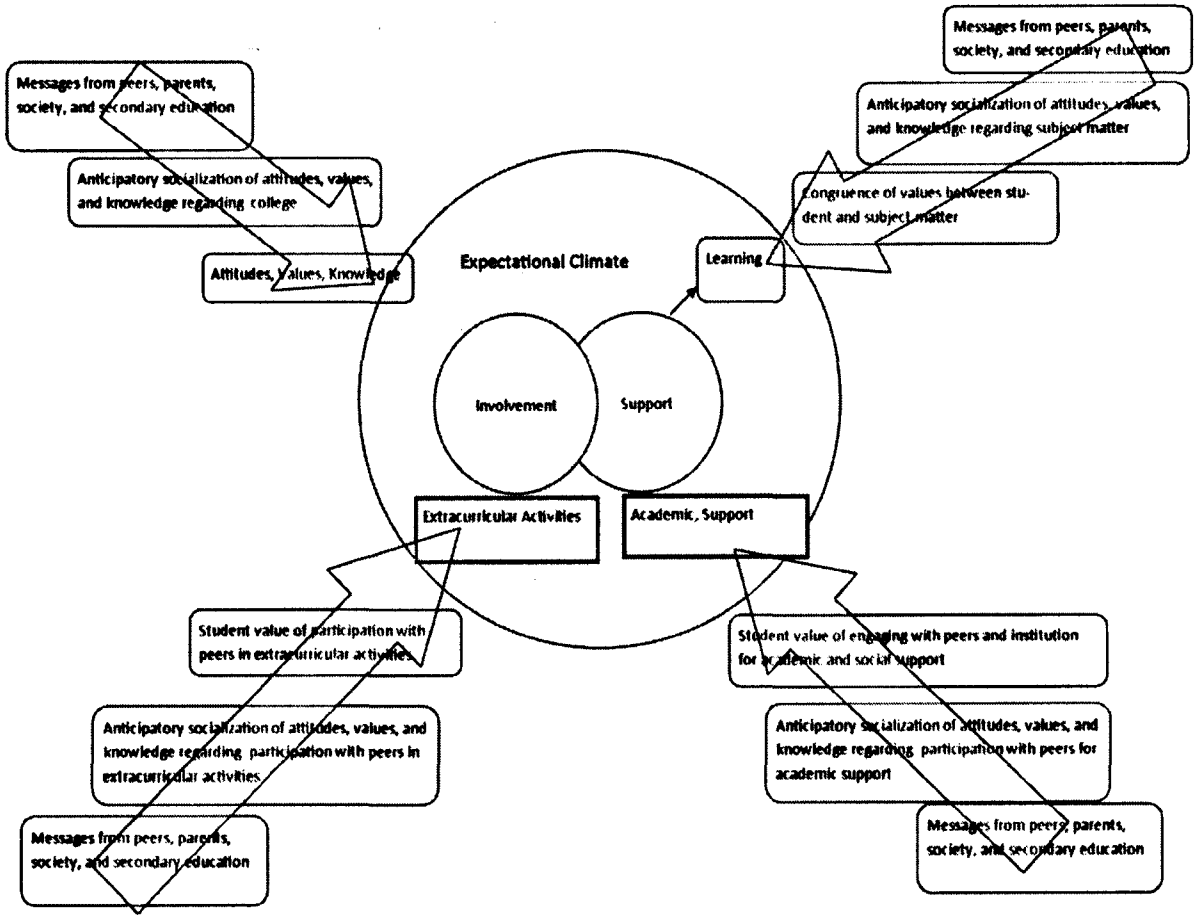


*Figure 2.* New model to understand African American male engineering student attrition.

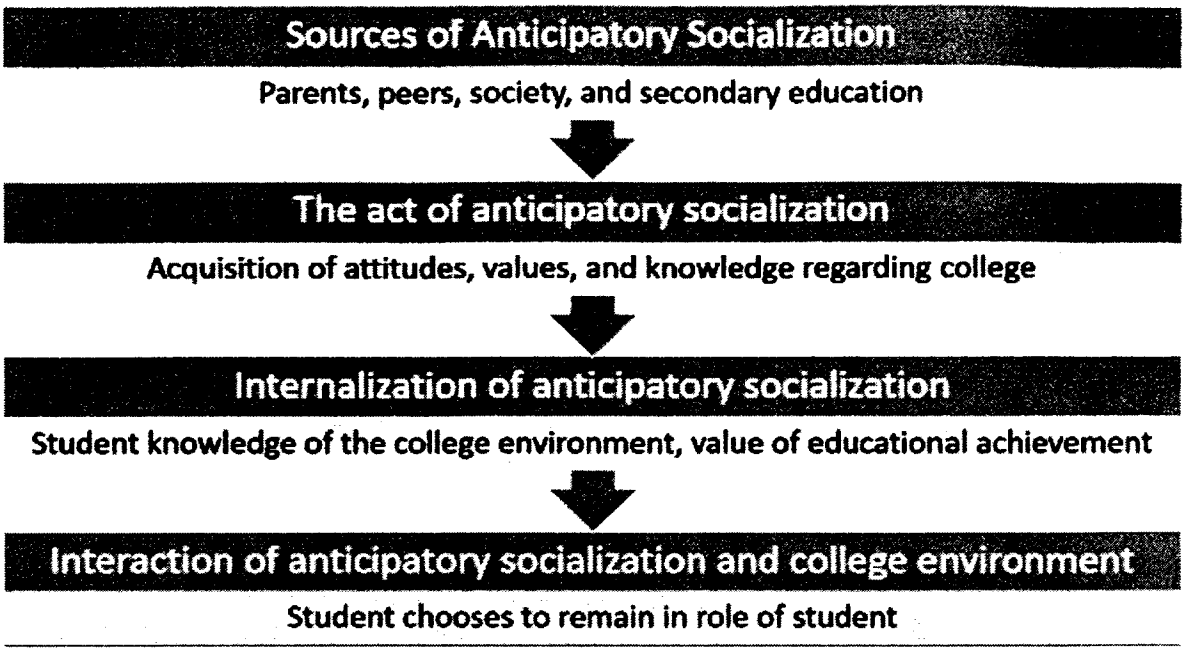


*Figure 3.* Interaction between anticipatory socialization regarding students' attitudes, values, and knowledge and the college environment.

**Student attitudes, values, and knowledge regarding the study of engineering.** Figure 3 shows the first relationship between anticipatory socialization and the college environment examined in this dissertation study. In particular, this pathway examines the role that anticipatory socialization plays in the process whereby students develop attitudes, values, and knowledge about college and the college environment that prevent student departure. As an example of the messages that students receive before entering college, Tinto and Pusser's (2006) model states that colleges must establish high educational expectations in order to increase the rates of student persistence.

Tinto and Pusser's (2006) work examines educational expectations from the perspective of the institution; however, students develop personal educational expectations prior to arrival at college (Attinasi, 1989; Braxton & Hirschy, 2005; Griffin, Pérez, Holmes, & Mayo, 2010; Kamens, 1981; Kuh & Love, 2000). Students' experiences prior to college contribute to the

values that students place on educational achievement (Bean, 1985; Cabrera, Birkum, & La Nasa, 2005; Museus, Harper, & Nichols, 2010). Students' educational aspirations, such as what degree to pursue and what level of education to obtain, are influenced by peers, parents and siblings (Krauss, 1964). Students who develop positive values associated with educational achievement are more likely to succeed in the role of student (Krauss, 1964; Merton, 1968; Tinto & Pusser, 2006). Students who value the pursuit of education beyond a bachelor's degree are less likely to leave higher education than those who intend to stop after completion of the bachelor's degree (Iverson, Pascarella, & Terenzini, 1984). The complex process through which a student develops educational attainment values also is dependent on the race, gender, and socio-economic status of the student (Museus et al., 2010). For example, family engagement in academic expectations appears to have a greater influence on African American students than on White students (Museus et al., 2010). That is, an African American student whose parents place value on education is more likely to be influenced by parental expectations than a similarly positioned White student (Museus et al., 2010). These elements of anticipatory socialization, all received by the student prior to entry in college, influence a student's decision regarding departure from an engineering program.

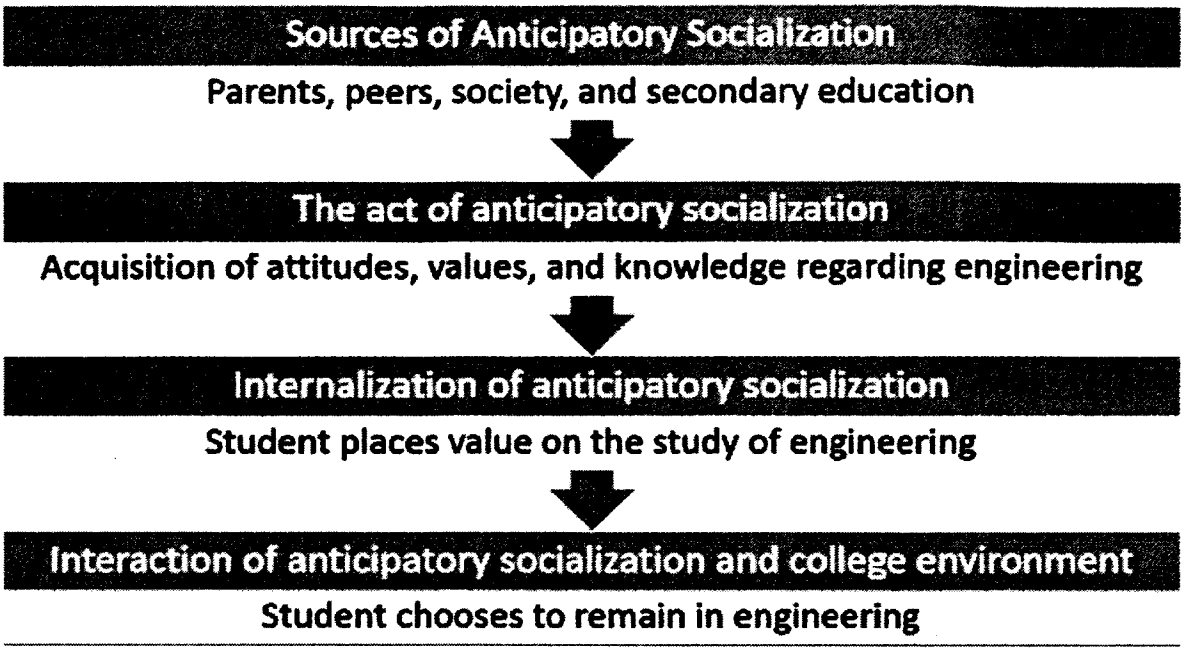


*Figure 4.* Anticipatory socialization of student's career values and relationship to college environment.

**Anticipatory socialization of student's career values and relationship to college environment.** Figure 4 illustrates the second pathway for anticipatory socialization to affect student decisions to remain in engineering programs that I examined in this dissertation study. Parents, peers, and secondary school all instill values and attitudes in students regarding appropriate careers (Beasley, 2011). In turn, parents and society influence the value that a student places on the skills, knowledge, and abilities associated with a particular degree. Furthermore, student career values are influenced by race, gender, and socio-economic status (Archer et al., 2012; Beasley, 2011; Bonous-Hammarth, 2000; Lucas, 2011; Seymour & Hewitt, 1997). For instance, African American students place particular value on careers that contribute to the community (Beasley, 2011). Students who value the contribution that their chosen course of study makes to society are less likely to change majors or leave college (Beasley, 2011; Keshishian, 2010). For example, a student who pursues a law degree and sees this degree as

benefiting society is more likely to remain within a pre-law program in college (Beasley, 2011). Additional examples of careers that students feel contribute to their community are social worker, doctor, and dentist (Beasley, 2011). Conversely, because engineering is not seen as a career that directly contributes to the community, it may be socially easier for an African American student to leave engineering for a more socially valued field (Beasley, 2011). This dissertation examined the ways in which students receive messages about the values associated with their chosen professions prior to college, and how these messages affect the persistence of the student.

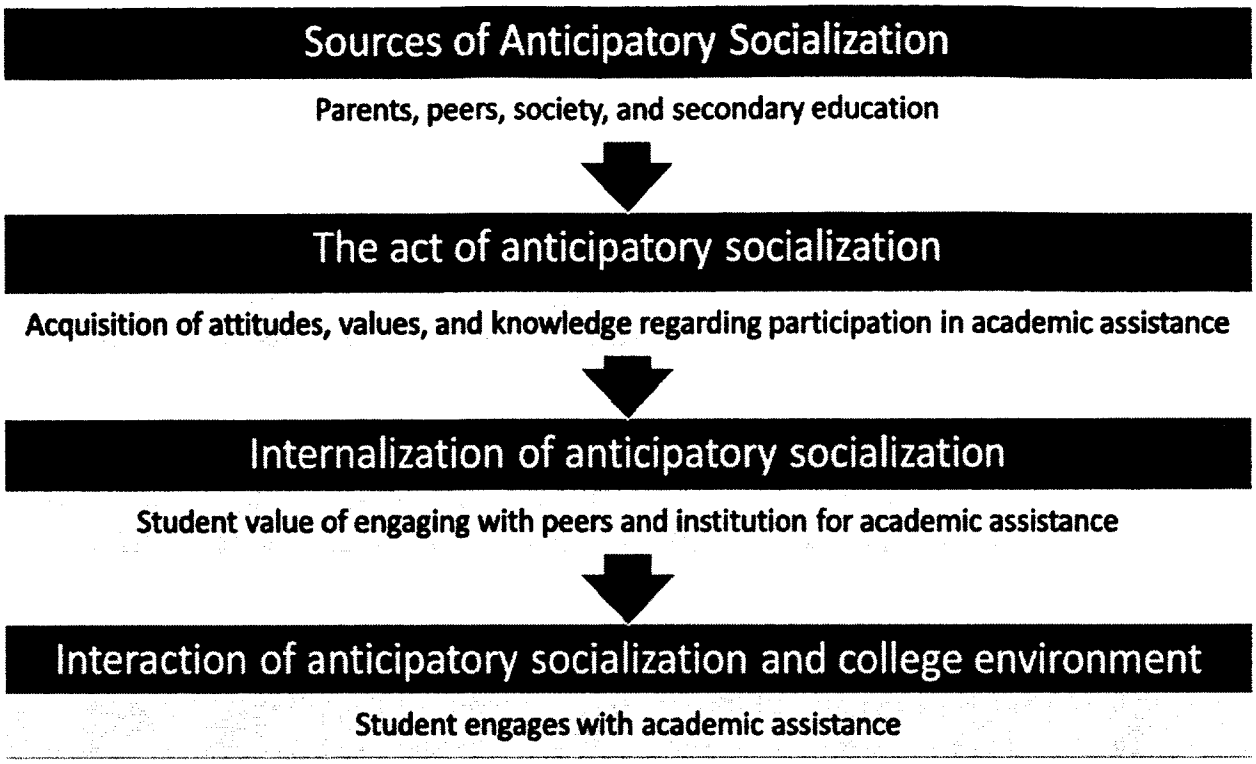


*Figure 5*. Interaction between student anticipatory socialization and academic assistance.

**Interaction between student anticipatory socialization and academic assistance.**

Figure 5 illustrates the pathway that socializes students to seek and accept academic assistance from peers and the institution. Peer support contributes to a student's ability to receive academic assistance (Beasley, 2011; Harper, 2006; Seymour & Hewitt, 1997). Likewise, student academic support from the institution reduces student engineering attrition (Seymour & Hewitt, 1997, Tinto & Pusser, 2006). However, before a student can receive academic assistance from either the school or peers, they must place value on seeking and receiving this assistance. This dissertation examined the ways that students are socialized to seek academic support from their peers and the institution prior to college entry.

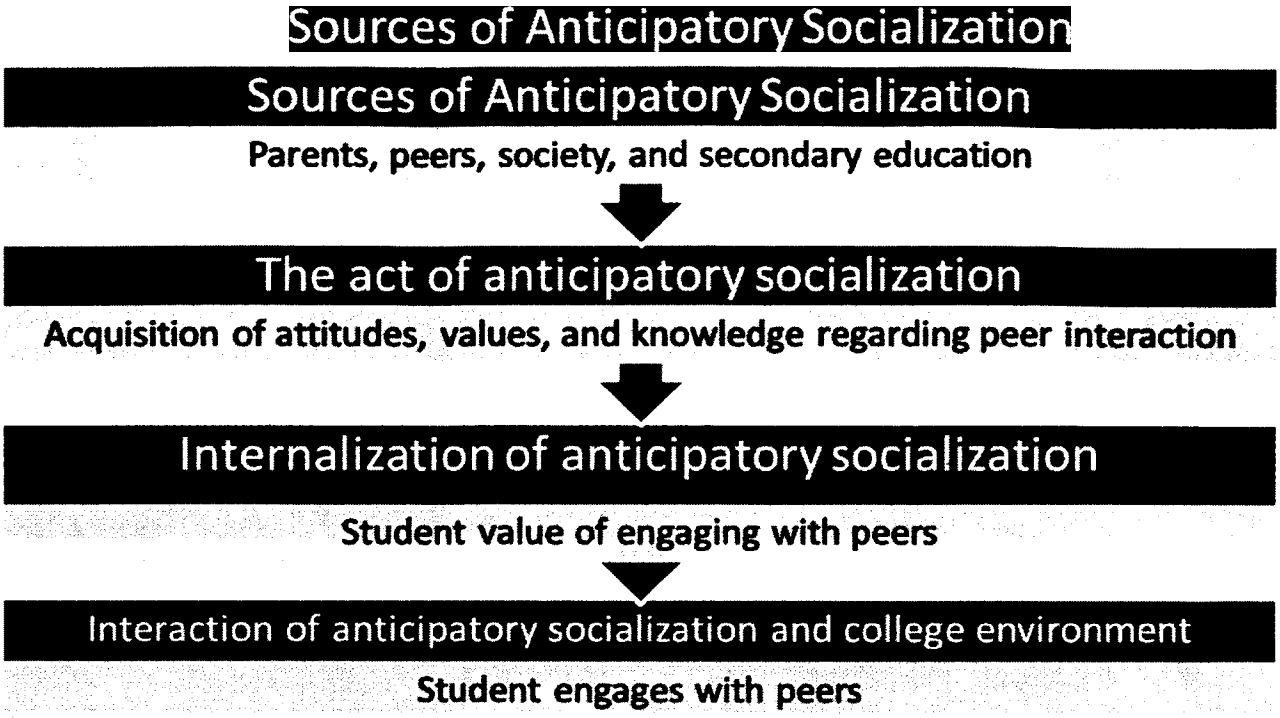


*Figure 6.* The relationship between anticipatory socialization and student membership in extracurricular activities.

**The relationship between anticipatory socialization and student membership in extracurricular activities.** Figure 6 elaborates the relationship between anticipatory socialization and student choice to join extracurricular organizations in college. Membership in professional societies and student organizations is an important source of peer support (Beasley, 2011; Harper, 2006; Hurtado et al., 2010). Students who choose to join professional organizations are less likely to depart (Harper, 2006; Seymour & Hewitt, 1997). Student membership in professional organizations decreases attrition in two ways. First, membership in a professional organization develops a student's sense of belonging (Harper, 2008; Hurtado et al., 2010). Second, professional organizations can be a source of both financial and academic resources for member students (Beasley, 2011; Harper, 2008). Although student membership in professional organizations is encouraged by colleges, ultimately, the student must place value on participating in these organizations to reap the benefits associated with membership (Beasley,

2011; Harper, 2006). For example, a student with limited free time may value the social aspect of interaction with a professional society more highly than social interaction with members of a fraternal organization (Foor et al., 2007). Students develop these values based on their anticipatory socialization experiences; that is, students learn about and come to value membership in one organization over another prior to their entry in college (Merton, 1968).

**Shortcomings of Proposed Model**

Not all aspects of Tinto and Pusser's (2006) model are related to the anticipatory socialization of the student. For example, although Tinto and Pusser (2006) model includes the abilities and skills of students in their model, these skills are not necessarily represented in student socialization. Likewise, Tinto and Pusser (2006) examine the commitment of the institution to student success, and this institution commitment in unlikely to directly affect student anticipatory socialization. However, this model of institutional action can still be used to examine the interaction of anticipatory socialization and African American male engineering attrition. Although elements such as institutional commitment and student ability are clearly mediating factors in student departure, this dissertation focused on what attitudes that students bring with them to college. The aspects of Tinto and Pusser's 2006) model that do not intersect with anticipatory socialization still support the examination of engineering attrition within an institutional context. This dissertation did not intend to demonstrate that institutional effects are not responsible for engineering attrition rates, but attempted to show that engineering attrition is a complex interaction of personal and institutional factors.

Anticipatory socialization cannot explain all aspects of male African American engineering student attrition (Merton, 1968). A student can adopt all of the values associated with a new role and still feel excluded from their prospective group (Merton, 1968). However, if

a group is willing to accept prospective members, appropriate anticipatory socialization will have a positive effect on the role aspirant's chances for group membership (Merton, 1968). Therefore, the interaction between a student's anticipatory socialization and the inclusiveness of the college environment will affect student attrition rates (Astin & Oseguera, 2005; Beasley, 2011; Kamens, 1981; McGee & Martin, 2011). Although anticipatory socialization cannot explain group acceptance in certain environments, anticipatory socialization can be used to understand the interaction between the preparation of students and the college environment. In general, anticipatory socialization can be seen as a means to smooth and speed the transition that a potential role incumbent experiences during socialization into a group, but it cannot completely explain why socialization fails to occur for certain students (Lucas, 2011; Merton, 1968). In this way, anticipatory socialization can be seen as a student's preparation for the socialization that occurs in college.

Although this model cannot completely explain the phenomenon of engineering student attrition, these limitations are somewhat beneficial in the sense that they may improve the focus of the study. The research question that guided this dissertation study focused on pre-collegiate experiences, rather than the experiences of the student at the institution. Anticipatory socialization is a broad theoretical construct, and using Tinto and Pusser's (2006) model limits the investigation to those aspects of socialization that affect the college experience. Likewise, Tinto and Pusser's (2006) model covers a broad spectrum of institutional effects on student attrition, and combining this model with the concept of anticipatory socialization limits the examination of attrition to the interaction of pre-collegiate experiences with the college environment. For example, I chose not to include the financial aspects of collegiate support present in Tinto and Pusser's (2006). Although finances are crucial for student retention, Ohland

and colleagues (2011) posited that student financial concerns occur later in college. Likewise, while the college's commitment to student success put forth by Tinto and Pusser certainly affects student retention, the college's commitment has to be examined through the lens of student interaction with the services that the college provides. Ultimately, college student attrition is a complex phenomenon, and no model can capture all personal and institutional aspects that contribute to a student leaving school, let alone deciding to depart engineering for a different major.

## Chapter Three: Methodology

The data for this dissertation were collected using ethnographic interviewing techniques (Spradley, 1979). Interviews were conducted within a descriptive multiple case study framework (Yin, 2003, 2009). The theoretical framework that I chose allowed this dissertation to examine not only the institutional and individual aspects that lead to student attrition, but also the relationship between the institution and the individual and how this relationship affects student attrition (Tinto & Pusser, 2006; Merton, 1968). My use of multiple case studies allowed for comparison between the experiences of students in two different institutions (Stake, 2006; Yin, 2003, 2009). I chose a descriptive case study methodology to provide a "description of a phenomenon within its context" (Yin, 2003, p. 5); specifically researching attrition within different institutions. In this dissertation, the phenomenon described is male African Engineering attrition, and the context is the two different institutions from which I drew participants. The cases that I examined in this dissertation are detailed in Table 1.

Table 1.

*Delineation of Cases Examined*

| University | Status of Students | |
|---|---|---|
| City State University[4] | Enrolled in Engineering | Departed from Engineering |
| Hobbes Central University | Enrolled in Engineering | Departed from Engineering |

I conducted the individual case studies using ethnographic techniques. The ethnography comprising the individual case studies in this dissertation focused on the experiences of male African American engineering students. In particular, the interviews sought to understand and

[4]For participant protection, the names of the universities studied in this dissertation are pseudonyms.

elucidate how these students' pre-collegiate experiences contributed to their decisions to leave or stay in an engineering program (Spradley, 1979). As Spradley (1979) suggests, "for human beings, what an act means is never self-evident" (p. 33). Thus, the act of leaving or staying in an engineering program cannot be interpreted for meaning by anyone other than the engineering student making these choices. In order to determine the meaning and reasons behind student attrition, the researcher must ask students directly about the process through which they came to leave the program (Spradley, 1979).

**Theoretical Considerations**

Tinto and Pusser's (2006) framework and the concept of anticipatory socialization (Merton, 1968) provided the theoretical framework used for this study. Tinto and Pusser's (2006) work emphasizes the role of the institution in student attrition. Anticipatory socialization attempts to explain student attrition by examining how a student's experiences prior to college enrollment influence student attrition (Merton, 1968). I chose to use case study methodology, as case study allows for comparison not only between students who stay in the program and students who leave the program, but also between institutions, and how institutional policy contributes to student attrition. I chose to use ethnographic interviewing techniques to collect data as the interviewees' stories allowed me to illuminate the anticipatory socialization experiences of participants.

The theoretical framework bounds the case study; as such, I chose the cases to consist of students who remained in engineering programs and students who departed from engineering programs. Tinto and Pusser (2006) emphasized the influence of the policies and climate of college on student attrition. Therefore, the cases I chose for this study examined two different institutions.

The interview protocol encompassed both anticipatory socialization (Merton, 1968) and Tinto and Pusser's (2006) framework. Parents, among others, influence anticipatory socialization (Merton, 1968). Therefore, the interview protocol included questions regarding the messages that parents give to students about careers, such as: *Have you ever talked to your parents/guardians about careers? If so, what types of careers did you talk about?* Second, the interview protocol included questions designed to elicit participant responses regarding their experiences in the engineering program. For example, the interview protocol included the question: *Do you think that your college encourages participation in extra-curricular activities? If so, what types of extra-curricular activities does the college encourage?*

**Case Selection**

In order to understand both unique and common elements of the male African American engineering student experience, I chose to examine four separate cases to provide examples of both commonality and uniqueness (Stake, 2006). The four cases do not represent four individuals; rather, they represent two institutions, and two groups of students. I chose cases that exemplified the differences between students who chose to stay in the engineering program and those who chose to leave. I postulated that students who chose to leave engineering had different experiences than those who chose to remain. Considering departing and persisting students as separate cases allowed the analysis of the specific aspects of each case while considering the common elements of the engineering student experience (Stake, 2006).

The second dimension that separates cases for this dissertation was the attending institution. The two institutions included in this dissertation were chosen for several reasons. First, existing relationships with the universities increased chances of site access. Second, the universities chosen were approximately the same size. Third, the universities chosen are both

public universities located in urban areas with similar population size. Below is a discussion of each data collection site and information associated with the demographics of each site.

**City State University**

City State University (CSU) was the first site selected for this dissertation. CSU was chosen for several reasons. The first reason was that I have established relationships with the engineering department at CSU as the result of previous academic work. This allowed for easier access to participants and increased chances of success recruiting participants. Second, CSU's engineering program is less than 15 years old and has a reputation for progressive policies, such as active attempts among faculty and administration to prevent student weed-out. I postulated that there were discrepancies between CSU's stated goals and the experiences of students in their engineering program.

CSU is located on an urban campus in a city with a population of approximately 200,000 people (Census Bureau, 2012). CSU has an undergraduate enrollment of approximately 22,000 students (Office of Planning and Decision Support, 2012). Of these 22,000 students, approximately 4,000 are African American, representing approximately 18% African American enrollment. This constitutes an overrepresentation of African American students as compared to the general population of the United States. Approximately 1,500 students are enrolled in CSU's undergraduate engineering program (CSU Engineering Department, 2011). Of these 1,500 students, 79% are male and 21% are female. Approximately 150, or 10%, of the students enrolled in CSU's undergraduate engineering program are African American, which is less than the university population of the African American students (CSU Engineering Department, 2011).

CSU's freshman engineering students have an average incoming high school GPA of 3.93 (CSU Engineering Department, 2011). The average SAT score for an incoming freshman engineering student at CSU is 1269 out of 1600 (CSU Engineering Department, 2011). The preexisting relationships, in combination with ease of data collection due to the proximity to the researcher and African American general enrollment rates higher than the general population rates, made CSU an optimal site to investigate African American engineering attrition rates.

**Hobbes Central University**

The second site I selected for this dissertation study was Hobbes Central University (HCU). I chose HCU for several reasons. First, I had established relationships with former administration of HCU. As was the case with access at CSU, these relationships allowed for easier access to participants and increased chances of success in recruiting informants. Second, the HCU engineering department has a reputation for encouraging African American participation in engineering programs through an extensive engineering scholarship program. HCU is located on an urban campus in a city with a population of approximately 600,000 people (Census Bureau, 2012). HCU has an undergraduate enrollment of approximately 10,900 students, of which 16% are African American (HCU Office of Institutional Advancement, 2012). Approximately 2,200 students are enrolled in HCU's undergraduate engineering program (Engineering Workforce Commission of the American Association of Engineering Societies, Inc., 2012). Of these engineering students, 13% are female and 87% are male (Engineering Workforce Commission of the American Association of Engineering Societies, Inc., 2012). Approximately 280 African American students are enrolled in HCU's undergraduate engineering program, representing 12.7% of the engineering student population (Engineering Workforce Commission of the American Association of Engineering Societies, Inc., 2012). The preexisting

relationships with HCU personnel, HCU's focus on recruiting and retaining African American engineering students and the similarities between HCU and CSU made HCU an optimal choice for a case study regarding male African American attrition rates.

**Selection of Participants**

Participants for this study were initially solicited from the African American engineering student populations of HCU and CSU. At HCU, engineering administrators sent mass emails to participants in the HCU engineering preparatory program. At CSU, engineering administrators sent an email to members of the National Society of Black Engineers. After the respective colleges sent these emails, I was contacted by two students at HCU and two students at CSU. At HCU, I relied solely on the initial two participants to recruit the remainder of my informants. At CSU, I was invited to speak at a general meeting of the NSBE chapter. I provided pizza for the general membership of NSBE, and explained the purpose of my research to the members. I then invited the male population of the NSBE chapter to sign up to participate in interviews, and I encouraged the students to recruit additional participants who had decided to depart engineering. Originally, I had intended to recruit participants in their third year of studies, based on the theoretical requirements established in chapter two of this dissertation. Selecting students in their third year of school was intended to ensure that informants had both the "thorough enculturation" and "current involvement" in the role of student that is required for an effective ethnographic study (Spradley, 1979, p. 47). Unfortunately, limiting participants to those in their third year of studies would have dramatically reduced the number of eligible participants. As a result of the limited number of participants available for the study, I opened the eligibility requirements to include male African American students who were currently enrolled in engineering or who had chosen to depart engineering after at least two semesters of enrollment.

Widening the eligibility requirements had the unintended effect of allowing me to observe the differences in student experience between students early in their educational careers, and also provided interesting and unexpected insights into how students' perception of the engineering program changed as they progressed in their studies.

I paid students 60 dollars for their participation in this research. Forty dollars was paid to the student prior to the start of the first interview, and 20 dollars was paid to the student upon completion of member checking. I chose to pay 60 dollars per participant, as this sum reflected both the amount of time I anticipated each participant to spend working with me and the approximate hourly rate paid by engineering internships.

**Profile of Study Participants**

I interviewed a total of 21 former and current engineering students for this dissertation. Twelve of the students were currently attending or had attended HCU. Nine students were attending or had attended CSU. Of the 11 current HCU students, four were former engineering students currently enrolled in a non-engineering major and seven were current engineering students. The remaining HCU student was a graduate of the art program at HCU and a former engineering major. Of the nine students attending CSU, eight were current engineering majors and one was a former engineering major.

For each student involved in the investigation, I attempted to collect the following information, all of which was self-reported: age, colleges attended, current college level, high school attended, SAT score, high school GPA, college GPA, current major, former major(s), career goal(s), and parent/guardian occupations. Because this case study was designed to examine the interaction of the background of the individual with the policies and climate of the institution, I needed to examine both the individuals that comprise the cases and a formal record

of their interaction with the institution (Stake, 2005, 2006; Yin, 2009). The information that I successfully obtained from students can be found in Appendix C. Four students chose not to respond to a request for this information.

To protect student confidentiality, I allowed each student to choose a pseudonym for use in this dissertation. All student interaction was governed by the protocol set forth in the Institutional Review Board approval of this research.

**Interviews**

I used a formal interview protocol to conduct the interviews (Appendix A). The questions used in the formal interview protocol were developed using: (a) the theoretical framework developed for this dissertation derived from Tinto and Pusser's (2006) framework and the concept of anticipatory socialization (Merton, 1968); (b) research literature regarding engineering student attrition; and (c) general principles of ethnographic interview techniques. The interviews ranged in time from 30 minutes to two hours and 45 minutes, and took place during one to four sessions with participants. The number of sessions, and time spent in each session varied based on the amount of detail provided by participants in response to the interview protocol and the time allotted by participants for the interview.

All informants signed an informed consent form as prescribed in the Institutional Review Board (IRB) protocol. The informed consent form is included in Appendix B. The format and content of this form are based on an informed consent form used by the World Health Organization as well as a similar form described by Creswell (Creswell, 2007; World Health Organization, 2013). The informed consent form advised informants that: (a) participant involvement in the research project was voluntary; (b) participants could withdraw at any time from the research without affecting their relationship with the researcher or the attending

institution; (c) all materials collected by the researcher used pseudonyms to protect participant privacy; (d) all references to participants were made pseudonymously; (e) all interviews were recorded and transcribed; (f) the work created from the interviews would be available to the informants; (g) all recordings, both paper-based and audio, would be available only to the researcher, with the exception of an outside transcription service.

**Interview Protocol and Relation to Tinto and Pusser's (2006) Framework**

The theoretical framework for this dissertation used both Tinto and Pusser's (2006) student attrition framework and the concept of anticipatory socialization (Merton, 1968). Tinto and Pusser's (2006) framework implies that if students seek academic help from instructors, campus help services, and peers, they are less likely to depart from college. An example of a question designed to elicit a response with regard to a student's help seeking tendencies is: *How did you decide to ask for or not ask for help with your studies in college?* Tinto and Pusser's (2006) framework also implies that student membership in campus organizations reduces a student's chances of attrition. An example of a question designed to elicit a response with regard to a student's peer group participation was: *How did you decide to join or not join campus organizations?*

**Interview Protocol and Relation to Anticipatory Socialization**

In addition to Tinto and Pusser's (2006) framework, the theoretical framework for this dissertation included the concept of anticipatory socialization (Merton, 1968). First, anticipatory socialization (Merton, 1968) was used to determine how the pre-collegiate experiences of students influenced their decision to depart from or remain enrolled in an engineering program. The interview protocol was structured using three sources of anticipatory socialization: family, peers, and formal education. Some examples of how the concept of anticipatory socialization

was included in the interview protocol were: *Did you ever talk to your parents/guardians about how to get academic support in college? If so, what types of support did you talk about?* Next, research literature was used to construct interview questions designed to determine the congruency of student values with institutional values. A prominent contributing factor to student attrition is the disconnect between a student's personal values and the values associated with a particular career (Beasley, 2011; Seymour & Hewitt, 1997). An example of a question developed to elicit responses regarding a student's value congruence was: *What careers do you feel have value to the community?*

**Interview Protocol and Relation to Ethnographic Literature**

Finally, all questions used in the protocol were divided into Spradley's (1979) three categories of interview questions: descriptive, structural, and contrast. Descriptive questions used in the protocol allowed the participant to describe their experiences in their own words (Spradley, 1979). An example of a descriptive question used was: *What types of relationships did you have with your peers in high school?* Structural questions allowed me to determine how participants had organized their knowledge (Spradley, 1979). An example of a structural question used was: *What steps did you take to choose your college major?* Finally, contrast questions allowed me to determine how participants differentiated their experiences in the collegiate environment (Spradley, 1979). An example of a contrast question used was: *What were the differences between your peer relationships in high school and in college?*

**Data Analysis**

The interviews were recorded using a digital recorder and transcribed verbatim by an audio transcription service. For preliminary analysis, I listened to the recordings of the

interviews while reading the transcripts, correcting any errors in the transcripts during this initial reading. After ensuring the accuracy of the transcripts, I began the analysis of the data.

Case study research requires that data analysis be performed concurrent to data collection (Merriam, 1998; Stake, 2006). I began the case study analysis with reflection and analytical memo writing. Additionally, during my initial review of the interview transcripts, I developed preliminary codes through a complete view of the transcripts. According to Merriam (1998), analytic memos are short interpretations of data that can be used to guide more formalized analysis. Analytical memos provided a framework for my further analysis of data and allowed me to develop an understanding of patterns in the raw data (Merriam, 1998). Also, the content of the analytical memos was guided by the overarching theoretical framework for this dissertation, which included Tinto and Pusser's (2006) framework and the concept of anticipatory socialization. Creating analytical memos within the theoretical framework established for this dissertation ensured that preliminary analysis of data was organized into categories that are effective at answering the research question (Merriam, 1998).

The next phase of data analysis I used for this dissertation study was "category construction" (Merriam, 1998, p. 179). According to Merriam (1998), category construction is the creation of themes from an analysis of the data collected throughout the case study process. Constant comparison involves separating data gathered during the ethnographic interviewing process into units, the smallest piece of data that is usable in analysis (Merriam, 1998). After constant comparison, I then compared these units of data and developed categories, or themes, from these transcripts for further analysis (Merriam, 1998). For this dissertation, I reviewed the data collected from interviews in an iterative fashion, meaning, I reviewed the first interview in a case and compared the data found from that first interview to the second interview in that case.

Afterwards, I reviewed all the interviews within a case and condensed the themes found in that case. After completing one case, I performed the same analysis on the next set of interviews within a case until all of the interviews in each case had been analyzed.

I then compared and contrasted the themes generated for each individual case with the remaining cases. These comparisons allowed for the discovery of themes common to the experiences of all of the participants in the research and also provided examples of contrasting experiences that helped to address the dissertation's research questions. In other words, all of the themes generated for ex-engineering students at HCU were compared with ex-engineering students from CSU. Likewise, all of the themes generated from engineering students at HCU were compared with ex-engineering students at HCU. From these comparisons, I generated themes specific to each institution and each student status. That is, I examined those themes that occurred for all students at HCU and all students at CSU. Figure 7 visualizes the relationship between themes.

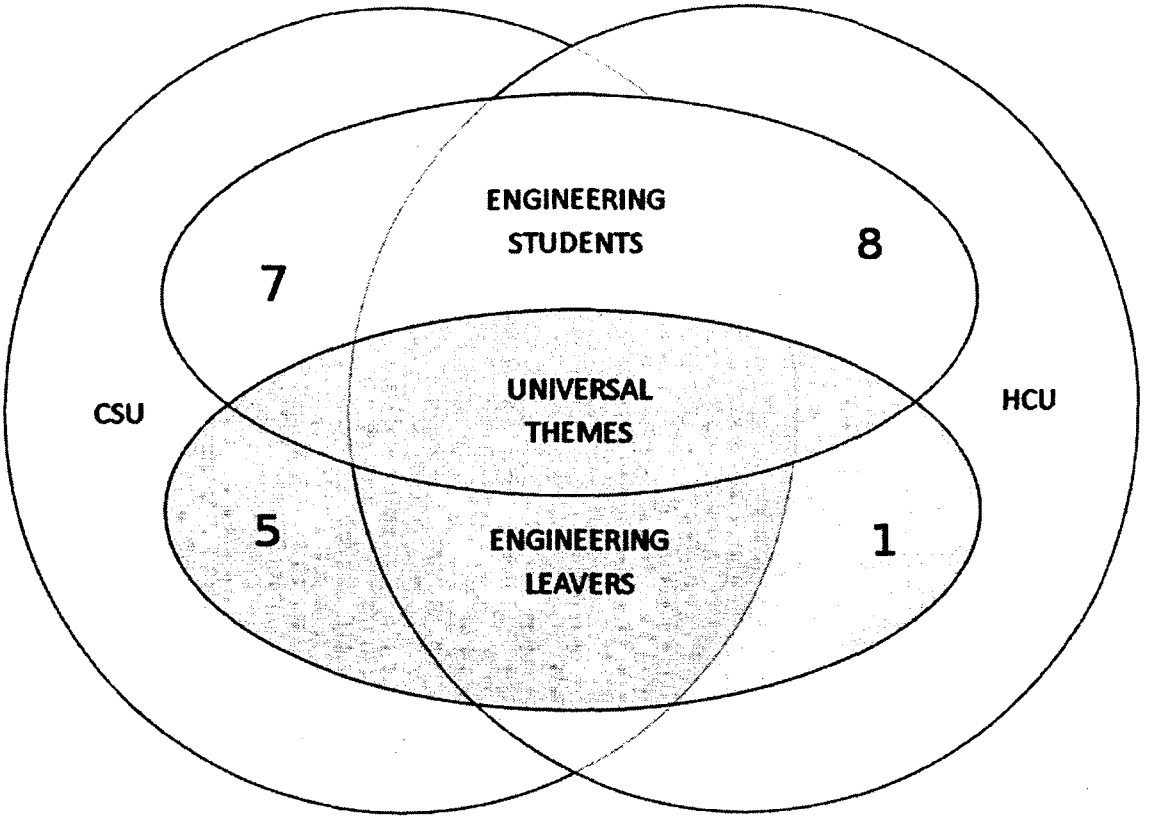


*Figure 7.* Depiction of how the data collected were analyzed as themes based on the cases selected for the dissertation study.

After identifying the supporting evidence for each proposed theme, I developed a series of assertions based on this evidence (Stake, 2006). Assertions are evidence based conclusions made through logical argument (Stake, 2006). I made these assertions within the theoretical framework established for this dissertation, which included elements of Tinto and Pusser's (2006) framework and the concept of anticipatory socialization. I supported the propositions that I made through the use of the findings and factors I developed as part of the analysis of the informant interview transcripts. The majority of assertions were based on experiences common to all students. As such, I reported the themes as they applied to all students, rather than

segregating the emergent themes by case. The manner in which I reported my findings was necessitated by the limitations I describe in the final section of this chapter.

**Validity and Trustworthiness**

To establish the trustworthiness of these findings, I used two methods of triangulation of the themes generated from the data. First, I conducted member checking. Member checking is the process of taking the assertions and themes developed during the qualitative analytic process back to the informants for review (Creswell & Miller, 2000; Merriam, 1998). The participants in the study then judged the quality of the assertions and themes based on their experiences (Creswell & Miller, 2000; Merriam, 1998). I then compiled themes based on my analytical memos and initial coding, and presented these themes to 18 of the 21 participants during a face to face follow-up interview that lasted between 30 and 90 minutes. The length of the interview depended on the detail of participant response. During these member checking sessions the participants were presented with the findings and asked what aspects of the themes they agreed with, what aspects of the themes they disagreed with, and the reasons for their agreement or disagreement. I encouraged participants to challenge my assumptions. Based on input from participants during the review of the themes generated from this data analysis, I reviewed my findings and made adjustments to them as appropriate. In addition, I included comments from these member checking sessions in the final data reported for this dissertation study (Creswell & Miller, 2000).

In addition to member checking, I conducted a peer debriefing to increase the trustworthiness of the themes developed (Creswell & Miller, 2000). Initially, I presented my initially developed themes to a scholar familiar with African American engineering attrition and requested feedback on the relevance and accuracy of these themes. After compiling an initial

draft of Chapter Four, I asked a two additional scholars who were familiar with African American engineering attrition to review the findings. None of the external scholars were associated with the institutions directly involved in this dissertation study. The scholars were then asked to comment on the themes and conclusions drawn from the data in Chapter Four. I then incorporated all peer debriefing suggestions and recommendations within my findings and conclusions.

**Limitations of the Study**

I became aware of several limitations of my research during the course of this dissertation study. First, I was able to interview only a limited number of participants who had left engineering. The lack of participants who left engineering meant that there was limited information from engineering leavers to contrast with those who stayed in engineering. This in turn limited the ability to contrast cases, particularly between those students who chose to stay, and those students who chose to leave. The experience of the students that I interviewed was different than the experience of those who chose to stay; however, because of the limited number of these interviewees, I was unable to develop themes regarding their experiences. Second, I believe that the responses of my participants were affected by my status as a White researcher interviewing African American students. Third, the manner in which I recruited interview subjects may have limited the diversity of participants. Fourth, my study may have been altered by the relationships that I developed with students over the course of my recruitment and interview efforts. I discuss each of the aforementioned limitations below. In addition to discussing the limitations of my study, I have also provided results and commentary from an external review of my findings at the end of this section.

**Limited number of participants who chose to leave engineering and associated limitations in case based methodology.** As previously mentioned, I was able to recruit only six students who had chosen to leave engineering out of a total of 21 participants. I theorize that the manner in which I recruited participants limited the number of engineering leavers who participated in my dissertation study. To recruit participants initially, I contacted students at both universities solely through college sponsored engineering organizations. As a result, all of the participants in the study that had chosen to leave engineering were recruited through their personal contacts with students who had agreed to participate in my study, rather than from the student body as a whole.

The limitations associated with participant recruitment extend to limitations in the case-based analysis that I chose to guide this dissertation. Because of the few participants who left engineering, particularly at CSU, I was unable to truly contrast the experiences of students who left at CSU, and those students who chose to stay in engineering at CSU. This lack of participants in turn, may have prevented themes from emerging that contrasted the institutional climates of each institution. In addition, the overall lack of participants who chose to leave engineering

Despite the lack of contrasting cases, I performed analysis of the data resultant from the participants in each case as stated in the methodology, that is, analyzing the groups of participants that constituted a case individually, and then progressing to the next case. In this way, I was able to determine the universal experiences of these students, but not necessarily differentiate the pre-collegiate experiences of those who stayed in engineering and those who chose to leave. However, the students who participated in the HCU Preparatory program, whose experiences will be covered in detail in the data and conclusions sections of this dissertation

study, illuminated clear differences in the pre-collegiate experiences of CSU and HCU students, as well as participants and non-participants in this preparatory program.

**The role of race.** Despite not having seen me prior to their interview, the participants in my dissertation study easily found me in the public spaces in which we held our sessions. As a 44 year old white male interviewing college-aged African American students, I am clearly an outsider to most of these students' experiences. First, as I obtained my undergraduate degree in chemistry in 1991, some participants' description of college life, such as grading practices and gateway classes, were foreign to my own college experiences. Second, and of greater impact, the racial difference between my participants and me not only tempered student responses about race, but also influenced my interpretation of participant experiences. To understand how the difference between my race and the race of the interviewees affected both the content and my interpretation of my data, I will first examine the general impact that insider/outsider status has on ethnographic interviews. Next, I will examine specifically how my status as a White researcher may have affected the responses of my African American participants. Finally, I will examine my data and interpretations of the effect of race on these students' college engineering experience, and propose further study to refine the understanding of the role of race in engineering student attrition.

The effects of insider/outsider status of the researcher on social research have long been debated (Merton, 1972; Young, 2004). A researcher's insider/outsider status is determined by social characteristics, such as race, class, and gender, shared by the researcher and their participants (Merton, 1972; Young, 2004). At the extreme of this debate, proponents of an insider approach to sociological research have argued that a researcher must be an insider to truly understand and interpret the organization and culture they choose to research (Merton, 1972;

Young, 2004). However, no researcher truly shares all of the cultural experiences of their participants, and the assumptions that participants make regarding a researcher that they regard as an insider may limit the detail of participant responses (Merton, 1972; Young, 2004). Young (2004), by appearances an "extreme insider" (p. 194), found that his insider status often confused and agitated his participants, as they were unsure why someone who was part of their culture would even bother to ask about aspects of their experience. Conversely, interviewees may make fewer assumptions when relating their experiences to an outsider, and may thus provide richer details (Young, 2004).

However, the outsider status of the researcher can inhibit participant responses, particularly with conversations about race (Young, 2004). Participants may not reveal critical data to an outsider for many reasons (Young, 2004). Interviewees' concerns about the motivations of the research can lead them to withhold information they feel would be detrimental to their community (Venkatesh, 2002; Young 2004). In addition to the general difficulties associated with being an outsider to the community, differences in race between interviewer and interviewee can create bias in interview responses (Singleton & Straits, 2012). In particular, Black participants interviewed by White researchers tend to "express more antiblack and conservative sentiments" (Singleton & Straits, 2012, p. 79).

Specific to this dissertation study, my status as an outsider was most evident in my research regarding the role of race in engineering student attrition. African American engineering students were dramatically underrepresented in the engineering programs that I examined. As Deton stated when introducing me to David, "you're looking at all of CSU's African American chemical engineers." However, based on conflicting information resultant from the interviews I conducted with current and former African American engineering students,

I found it difficult to draw conclusions regarding how this lack of representation affects African American engineering students as a whole. I attribute a lack of consistent themes regarding the role of race in engineering student attrition to my role as an outsider to the African American engineering student community.

The students I interviewed presented a dichotomous view of the isolation experienced by African Americans in engineering programs. All of the participants informed me that they understood that an African American student could experience isolation in an engineering program. However, most interviewees indicated that they did not personally experience such isolation, instead saying that they were able to easily form a community on campus despite the limited number of African American engineering students on their campuses. As a result of these contradictions, no clear conclusions emerged from the data regarding race, isolation, and engineering attrition.

I attribute the diversity of responses in part due to my status as an outsider. Given the racial difference between me and the study participants, some interviewees may have engaged in the behaviors postulated by Singleton and Straits (2012), that is, minimizing the role of race in the interviews regarding their experiences as an engineering major. In addition, I postulate that some interviewees may have minimized the sense of isolation they experienced as a racial minority due to a sense of pride. Participants, interpreting their admission to feelings of isolation as a sign of weakness, may have not wanted to show themselves as vulnerable. These observations of participant reticence regarding sharing potentially vulnerable experiences echoes Majors and Billson's (1993) work regarding the "cool-pose" adopted by African American males as a means to preserve pride.

**Participant recruitment.** When I initially contacted the colleges that participated in the study, I intended to gain access to engineering classes as well as the general population of students. By gaining access to a wider variety of students, I had hoped to diversify my participant pool. Unfortunately, both colleges were unable or unwilling to allow me to recruit students directly. This reticence on the part of the participating colleges led to my recruiting students through NSBE chapter email lists and snowball sampling through personal contacts made with the first students that I interviewed. Presumably, study participants who were involved with a campus organization designed to encourage engineering students would limit the diversity of student experience in my interviews. NSBE membership is designed to encourage and support students. Interviewing only NSBE members may have portrayed the engineering environment as less isolated, and more supportive of African American students.

Working with NSBE was beneficial in some ways, as a portion of my research framework was concerned with membership in professional organizations like NSBE. Organizations such as NSBE contribute to a student's sense of belonging and can be a source of both financial and academic resources for member students (Beasley, 2011; Harper, 2008; Hurtado et al., 2010). As such an organization, NSBE could be considered to be a factor in students' decision to remain in engineering. However, the large number of students involved in NSBE who participated in my study limited my ability to make comparisons between the experiences of engineering students who were and were not members of professional organizations.

Similarly, the students who had chosen to leave engineering who participated in this dissertation were recruited by their friends and colleagues who had remained in engineering. In particular, a large number of both current and former engineering students recruited at HCU

were members of a historically Black fraternal organization. Because I recruited through an established community network, students may have answered questions about isolation and sense of community differently than if students had been recruited through their engineering classes. In particular, the students I interviewed may have felt less isolated than an engineering student who did not have the benefit of community membership. Therefore, participants may have answered questions about isolation in a more positive fashion than a different sample of engineering students.

**Participant reimbursement and researcher relationship to participants.** I made the decision to reimburse participants for their time spent in interviews based on two factors. First, offering a financial incentive would result in greater participation. Second was the fact that participants were required to spend up to five hours of their time responding to questions, gathering personal information, and establishing interview times. Given the financial reasons for student attrition mentioned by several authors (e.g. Seymour & Hewitt, 1996), forcing students to choose among a paying job, contributing to a study that would help similarly situated students, and studying their coursework was unethical. Some students indicated that their primary consideration was the financial compensation offered for participation. However, one student offered to participate for free, and at least one student, James Franco, had not been told of the compensation offered, and was surprised when I made arrangements for payment. I recognize that financial compensation may bias participant responses to please the researcher (Ackerman, 1989; Cook, 2012; McKeganey, 2001). Likewise, reimbursing respondents insufficiently may compromise participant responses, as too little payment cheapens the contributions of the interviewees (Ackerman, 1989; Cook, 2012; McKeganey, 2001). Therefore, I made the decision to pay students approximately the same hourly rate that they could expect to receive for on-

campus work such as assistantships or tutoring positions. By offering the same amount as students could expect to earn for other campus based endeavors, I hoped to neutralize the problems associated with over- and under-payment (Ackerman, 1989; Cook, 2012; McKeganey, 2001).

In addition to the possibility of monetary compensation biasing participant responses, although I knew none of the participants before I started my research, I have developed personal relationships with several of the students that I interviewed. To help to obtain access to participants at the CSU NSBE chapter, I agreed to provide pizza for students and to speak to the chapter regarding the importance of communication skills in the engineering workplace. I have also provided internship information to several participants. Similar to the monetary compensation offered to participants, these relationships may have encouraged the students I interviewed to provide answers that they believed I was expecting. Conversely, these relationships may have contributed to more honest answers based on trust developed between myself and the participants.

**External review.** An external review of chapter four's themes found that the themes that emerged from an analysis of the interviews were trustworthy, and were consistent with the reviewers' personal and professional experience (C.D. Fermin, personal communication, August 19, 2014; J. Smith, personal communication, March 18, 2014). However, one external reviewer commented that the study would have benefited from creating a stronger tie between elements of anticipatory socialization and specific academic outcomes, that is, a more quantitative linkage between anticipatory socialization and engineering attrition rates (L. Hannon, personal communication, August 19, 2014). In addition, this reviewer conveyed that anticipatory socialization is not the sole reason for student attrition, and that other preparatory measures

contribute to a student's decisions regarding engineering enrollment (L. Hannon, personal communication, August 19, 2014). I agree with this assessment; however, my aim with this dissertation study was not to establish causality, but rather, to explore the anticipatory socialization experiences of students, and how these experiences interact with existing elements of the college engineering experience.

## Chapter Four: Reporting the Data

This dissertation study examined the experiences of 21 African American male current and former undergraduate engineering students at HCU and CSU[5]. More specifically, this study examined the factors that contributed to these students' decisions to remain enrolled in their engineering major. Using Merton's (1968) concept of anticipatory socialization as part of my theoretical framework for this investigation, I wanted to know how pre-collegiate experiences shape students' perceptions of and reactions to their college environment. To better understand how these pre-collegiate experiences interacted with the college environment, I used Tinto and Pusser's (2006) model of institutional action to conceptualize elements of the collegiate experience that contribute to engineering student attrition. Three major themes emerged from the data, including: (a) the lack of anticipatory socialization that students experienced in high school, (b) the inability of students' parents to prepare them for the college environment, and (c) the ability of a college summer bridge program to successfully anticipatorily socialize students to the college engineering environment. The following sections provide a more detailed description of how the themes experienced by the participants relate to anticipatory socialization, Tinto and Pusser's model of student retention, engineering student attrition, and the role that values play in engineering student departure.

[5] Information regarding student major, standardized test scores, and GPA can be found in Appendix C.

**Unprepared: The High School Experience**

*You don't know how to study, because high school is too easy. There's no real need to study for any class in high school. You could pretty much get through it barely giving much effort... In high school you really don't develop those skills of prioritizing, or really managing what's important, you just kind of blow everything off.*

-Ian, junior in mechanical engineering, HCU

Of the 21 students interviewed for this dissertation, 20 indicated that their high school did not adequately prepare them for the demands of the college engineering curriculum. However, the lack of preparation prior to entry in an engineering program did not seem to differ between students who stayed and students who departed. In turn, the ways in which high school failed to prepare these students for the college environment interacted with several elements of Tinto and Pusser's (2006) model of institutional action, primarily the need for students to form community and receive academic assistance.

For instance, the participants felt that they were unprepared to major in engineering because their high school failed to provide a environment that represented the challenges that engineering students would face in college. The students I interviewed for the study indicated that high school failed to prepare students in three ways. First, the participants were unprepared for the quantity of work required in an engineering program. Second, students felt that high school was too easy, and conditioned them to expect success at a minimal level of effort. Finally, the interviewees for this study felt that there was a mismatch in the intellectual level of the learning objectives between high school and college curriculums. Regardless of whether the participant had chosen to remain in or leave engineering, they felt that high school had not

provided them with an opportunity to practice the skills necessary for a smooth transition to the collegiate engineering environment.

**High school and the nature and quantity of work required in engineering school.** Tinto and Pusser's (2006) model posits that to be successful, students need to arrive at college with the attitudes, values, and skills that allow them to successfully navigate this new environment. Twenty of 21 participants felt that high school did not provide an environment that allowed the development of the attitudes, values and skills required of a successful engineering student. In part, the students felt that the limited work required for success in high school led them to have expectations of similar work load in college. However, the students noted that their academic skills such as mathematics were not lacking, but rather they experienced deficits in their ability to apply these skills to the new college environment. In addition, the participants did not feel that they had developed the study skills necessary for success in engineering in their respective high schools. As a consequence, by failing to provide an appropriate level of academic rigor, the interviewees' high schools did not anticipatorily socialize them to develop the study or time management skills necessary to succeed in a college or post-secondary engineering major. For instance, James Franco, a mechanical engineer at HCU, described the differences between the volume and intensity of the work in high school and in college:

> In high school the workload is just easier. So maybe the hardest stuff that you get to in high school...you can afford not to know [it] and...still get an A in the class. That's like the basic stuff in college; so then you're like oh, I have to know all this and it's harder than what I did in high school...I definitely think that the work load in high school

> can...skew people's ideas of what hard working is or what really it takes to get good grades. [Stayer, Sophomore, HCU]

James Franco's view that high school failed to acclimate him to the volume and intensity of work in college was shared by Ian:

> A lot of students...will tell you how they had 4.0's in high school, but people have told me several times that, 'Oh I used to do my homework during lunch,' or 'Oh I used to do my homework like during class and still turn it in and get an A.' That's not preparing you for the college setting, because nobody in college will tell you that. [Stayer, Junior, HCU]

David, a senior in chemical engineering at CSU, explained that the lack of preparation for the intensity of academic work in college was caused by high school teachers failing to provide examples of this difference:

> I heard [my high school teacher] say, 'College will be more difficult than high school'...But the fact that they can't really emphasize that in terms of like actually showing us what it will look like, that's where people choose to ignore it... because [as] the saying goes, 'I don't care what you say, I care about what you do.' [Stayer, Senior, CSU]

High school teachers told students about the volume and intensity of work that students could expect in college, but did little to provide work that exemplified the college experience. By not providing students with a level of academic intensity that matched college expectations, high schools failed to anticipatorily socialize students to expect the volume of work required for college success. Therefore, students experienced a mismatch between the work that they anticipated would be required and the work that was actually required for collegiate success.

The differences in academic expectations between high school and college also contributed to participants overestimating their academic abilities.

**High school made participants over-confident in their academic abilities.** In addition to a lack of preparation regarding the intensity and nature of college work, a majority of the participants indicated that the ease with which they completed high school led them to expect that they would experience similar facility with academic success in college. Students were anticipatorily socialized to not need academic assistance with their studies. According to Tinto and Pusser (2006), academic assistance is essential to student success. In this particular instance, a majority of the participants in this study were not socialized to expect or ask for help. Concomitantly, many of the interviewees initially declined to take advantage of the academic services provided by the college. In many cases, the delay in accepting academic assistance created adverse effects on participants' grades and prospects for retention. For instance, John, a junior currently enrolled as a mechanical engineering student at HCU, described how his lack of academic assistance in high school contrasted with his college experience:

> One issue I had in high school [is that I] kind of became elitist based on the fact that I knew I didn't need help...in the beginning [of college] I was constantly being offered help and never taking it. [Stayer, Junior, HCU]

Much like John, James Franco felt that students developed an expectation of self-reliance in high school, and these expectations led students to refuse academic assistance in college:

> Because they've been successful in the past...even though they know that they are not quite there yet. They'll think that they will get there because it's always worked out for them in the past. And that's like going back to the difference between high school and college. You don't always get there because you're a smart kid; now it's like you have to

> go to someone else for help. Because no matter how smart you are, you might not get a certain thing. [Stayer, Sophomore, HCU]

Bob, a junior in information systems and accounting and engineering leaver at HCU, emphasized how the ease with which he completed high school as an individual differed from his experience in college:

> I didn't really need help in high school; I was in AP classes and all other classes. As long as I was in class, I can get the information straight from the teacher, and you know be fine for homework and be fine for projects. And then in college [it's] a different world and it's like I don't know what to do now – [I didn't know] that you can ask questions and get help and then you should actually work with people. [Leaver, Junior, HCU]

Participants' success in high school led them to expect similar success in the college environment. As a result, participants anticipated being able to continue the academic behaviors that led to their high school successes. The participants did not seek academic assistance in high school, and therefore anticipated that they would not need to seek such assistance in college. The subsequent lack of academic assistance seeking behaviors contributed to poor student performance.

**High school did not provide students with opportunities to develop critical thinking skills.** The participants felt that the depth and nature of knowledge required for success in high school was different than that required for success in college. The students interviewed for this study felt that high school instruction relied heavily on memorization, and less on application of knowledge. Therefore, participants were anticipatorily socialized to expect a similar level of instruction and resultant assessment in college. Ralph Lauren, an exercise science major and

former mechanical engineering student at CSU, explained the difference between the levels of understanding required for college and high school:

> In high school you can regurgit[ate]. They say, 'OK, five plus five is 10.' So then, you get to the test and they ask you what five plus five is. And you [say], 'Oh, it's 10, I remember that.' And here [in college], it's not that way. If they say, 'OK, five plus five is 10.', he will give you a test and this says two plus two plus two plus two plus two, 'I guess it's 10.' Like that. You got to learn to look at the information in a different way. And different ways of how to get about that – to actually learn. [Leaver, Sophomore, CSU]

Similarly, Thomas, a sophomore currently enrolled in the mechanical engineering department at CSU, described the difference in the level of thinking required between high school and college, emphasizing that engineering starts off at a much higher cognitive level:

> It's [engineering is] a lot of application and synthesis, as well as evaluation. You're doing labs, first you have to learn the application of the concept, and now you know how to do this, [you have to] design something that does this. So, sitting in a lecture, the professor might be writing notes or doing examples on something new that you haven't learned before, and it's not something where you start out at memorization, like these are the terms, memorize these terms. It's more of starting off on the application level, and then you evaluate it, and then you go back and try to apply it yourself.[6] [Stayer, Sophomore, CSU]

[6] The similarity between Bloom's (1956) descriptors and Thomas' are not accidental. I asked him why he chose to use the terms application and synthesis, and he indicated that in a study skills class that he took in his freshman year he was taught about Bloom's taxonomy.

Daniel, a junior in mechanical engineering at CSU, further stressed the discrepancy between high schools' emphasis on memorization and colleges' reliance on higher order thinking skills:

> There is definitely a difference between the tests that are taken in high school and in college. High school was more memorization. Memorization to the, to the point if I had this formula down I'd just, you know, plug in the numbers, just look for the formula ...Then you're good to go. But college is how you do it. You know, what are the, the key concepts behind making this or that work. [Stayer, Junior, CSU]

College engineering student performance is assessed based on the student's ability to transform and apply novel information. Conversely, student evaluation in the high school environment measures students' recall abilities. Therefore, although high school may have provided these participants with fundamental knowledge, it failed to prepare students to utilize this knowledge. Students were forced to adapt to both the requirement for application of knowledge and how knowledge application would be assessed.

**No One Can Do It Alone: Academic Assistance in Engineering**

Both current and former engineering students discussed the importance of utilizing academic assistance in order to successfully complete a major in engineering. The available academic support described by students is divided into two categories: assistance provided by the college and peer based assistance. Peer based assistance is composed of student formed study groups and peer-to-peer academic interactions. College based assistance is defined as the resources provided and promoted directly by the college, such as tutoring centers, teaching assistants' sessions (TA), and professors' office hours. In the following sections I will discuss peer based assistance first, followed by an examination of the role that the college

plays in providing assistance. After discussing the types of assistance available to students, I will discuss the reasons students seek or reject academic assistance. Tinto and Pusser (2006) emphasized the importance of college provided academic assistance in contributing to student retention, suggesting that schools offer tutoring and other services to support student learning. That said, if students do not seek or know about college based assistance, they cannot benefit from it. For the purposes of this dissertation I was interested in understanding the factors that pertain to students' choice to seek academic assistance and how these choices related to a student's anticipatory socialization. According to the participants in this study, the following factors informed a student's decision to seek academic assistance: (a) student socialization to expect not to need academic assistance, and (b) a student's sense of pride interfering with their desire to seek academic assistance.

**Peer academic support.** Students recognized early in their college experience that academic success in engineering was unlikely without the support of fellow engineering students. The notion of peer academic support stands in contrast to participant experiences in high school, where students were not expected or encouraged to work in groups. The high school experience of participants failed to provide anticipatory socialization regarding the need for the formation of support groups. For example, David, a senior in chemical engineering at CSU, expressed the need for academic support from fellow students:

> That's actually one of the main ways how a lot of us got [through] the engineering program. Unless you were really, really, smart and knew exactly what you needed to at all times, I can't even tell you how many times people have got into study groups and literally studied together all the material for hours and hours and hours... I see it now...those junior and sophomore classes in engineering, that's how they get through

> their classes. They do it together, it's never a one man team. It's always like a group effort. [Stayer, Senior, CSU]

The need for peer group interaction to provide academic assistance was also expressed by Cyrus, a junior in information systems and accounting at HCU and former mechanical engineering major, who felt that success was impossible without the assistance of study groups:

> Like engineering, if you didn't have a study group, you were bound to fail. There were probably like two people in a class of 200 and something who are able to do stuff by themselves and like everybody [else] had to have a group. [Leaver, Junior, HCU]

Bob, a junior in mechanical engineering at HCU, further reiterated the need to seek academic assistance from peer groups, and contrasted his current situation with his high school experience:

> In high school, it's kind of more of an independent thing. You didn't really need to depend on anybody else for anything, whereas engineering is more of a team-based curriculum and they [the college] encourage you to work with other people, to do homeworks, to study for tests, to work on projects, and things like that. [Stayer, Junior, HCU]

The participants stated that formal opportunities for academic support provided by the college decreased in higher level classes. For example, participants found that the college provided multiple academic support mechanisms for foundational classes such as calculus and introduction to engineering. However, for advanced engineering classes, participants indicated that there were no tutoring or additional instructional sessions available. Therefore, the participants felt that the ability to form study groups was of increased importance as a student progressed further in an engineering major. Ian, a junior enrolled in mechanical engineering at

HCU, indicated that opportunities for college provided academic assistance decreased as a student progressed towards graduation:

> As classes get harder...there aren't really any TA's or discussion sections and that really probes you to kind of have to reach out by yourself; the help really isn't given to you. You rarely see the department offering help more. [Stayer, Junior, HCU]

The feeling that college provided less formal support as students progressed was repeated by Cyrus, a junior in accounting and information systems and former mechanical engineering student, who said, "as you get into [higher] classes, the classes get smaller and smaller; same thing with the number of people who can help you."[Leaver, Junior, HCU]

Despite students feeling that colleges provided fewer academic assistance options for higher level students, all students indicated that their college provided academic support to lower level students. There is clearly a dichotomy between the needs of the students for academic assistance and the college's provision of such assistance, which in turn leads students to seek peer support.

Academic support offered by the colleges included: (a) discussion sessions in which students performed group guided practice, (b) individual tutoring sessions with college provided tutors, (c) group tutoring sessions with college provided tutoring, (d) teaching assistant (TA) office hours for individual instruction, and (e) professors' office hours for individual instruction. I theorize that the decrease in support for higher level students stems from the college's assumption that once students have successfully completed entry level classes, they have shown the ability to succeed without additional support. However, the decrease in academic support as

students progress may result in a deferment of student decisions to leave engineering, rather than preventing these departures entirely.

**Pride and its role in students' seeking academic assistance.** The participants in the study discussed the role of personal pride as it contributed to their reluctance to seek academic assistance from either peers or the college. Majors and Billson (1992) conceptualize pride as coping mechanism for African American males to "deal effectively with [their] environment" (p. 38). Pride can serve as impediment to African American males seeking assistance in an academic setting (Palmer, Davis, & Maramba, 2010). The participants that I interviewed confirmed that their and their peers' sense of personal pride interfered with students' ability and desire to seek help. Cyrus, an accounting and information systems major at HCU and engineering leaver, observed that pride kept students from seeking assistance:

> I would actually say that [pride] was probably like the biggest reason why [people] don't look for academic assistance, from what I've seen...once you get to a point where you are kind of like ahead of people, you get used to it. [Leaver, Junior, HCU]

Ian, a junior currently enrolled in mechanical engineering at HCU, supported Cyrus' observations when recounting his freshman year at college:

> I was very prideful freshman year. I tried to do things by myself, you know. I was like 'I don't need anybody's help, I can do this, I can study by myself and I know I'll get it.' And you know, that really cost me...I made a C my freshman year...it was chemistry. Coming in, I had taken AP chemistry in high school, and so I was like 'oh man, I know I don't like chemistry, but I'll be fine, you know.' Really, I wasn't fine, and I struggled with it a lot, but I didn't ask for help because everyone else was doing so well. I was like, 'man, I don't want to ask for help'. They're doing good and I'm not doing good, so

> let me try and study by myself. And yeah, that really cost me, but after freshman year, learning that it is OK to ask for help, that sometimes you're not going to get everything, that really helped out. [Stayer, Junior, HCU]

Abraham, a mechanical engineering stayer at CSU, also felt that pride played a role in students' refusal to seek academic assistance:

> I have engineering friends that are very prideful, they make good grades, but they get this sense of entitle[ment]. You know, a sense about themselves like, 'if I go seek help, you know that translates into...weakness or incompetency.'[Stayer, Did not respond, CSU]

Several students indicated that their sense of pride came from being one of the few African American students in the engineering program. I postulate that African Americans' sense of pride in an engineering setting may stem from the exclusivity of their position. Deton, a senior in chemical engineering at CSU, expressed his feelings regarding asking for academic assistance, and how he saw reliance on others as reflecting poorly on African Americans:

> I don't want to ask a question, I don't want to put myself out there, because I will look stupid. I'm the one dumb Black kid in my class kind of thing, because I'm the only one there. So the moment [I look stupid, people are thinking] 'damn, [he] is not supposed to be here,' that kind of thing. So there is that part, but then it also came to a point of thinking to myself at the end of the day, the only person who is getting a degree is me, so it didn't really matter what these other people are thinking. I can look foolish for four or five minutes before I actually get the answer. So therefore it took me to, I guess the sophomore year before I was allowed to start asking people for help on occasion, and that was only with like close people who had gotten to know me well enough. [Stayer, Senior, CSU]

Brandon, an engineering major at CSU, explained how his sense of pride, and his subsequent decision to not seek academic assistance, likewise was influenced by being one of the few African American engineering students:

> [Pride] definitely plays a role. I mean, being that one student out of everybody who has to get help...I can see pride playing a big role, and you don't want to make it seem like you are weaker or make it seem like you are not as good as everyone around you. So you try to keep up with them without doing extra help. [Stayer, Did not answer, HCU]

I posit that the sense of pride comes from two sources. First, students developed a sense of pride in their studies based on their previous academic achievement. In other words, students had been anticipatorily socialized by their high school experience to expect success. Second, students felt a sense of pride from their exclusive standing as African Americans in the engineering program. As reported by Palmer, Davis, and Maramba (2010), this sense of pride prevented students from seeking the academic assistance offered by the college or peers. As academic assistance is one of the elements Tinto and Pusser (2006) described as being crucial to student retention, student refusal to seek such assistance is detrimental to student retention.

### *My Brother Was a Mechanical Engineer*: The Role of Family in Social Preparedness in an Engineering Program

The students who participated in this dissertation study came from diverse socio-economic backgrounds, with students' parents representing a wide variety of careers, ranging from school custodians, to entrepreneurs, to senior level government executives. That said, even those parents with college and professional experience failed to provide anticipatory socialization experiences that were useful to students in their transition to college. Rather,

students received more information regarding college from their siblings than from any other source.

**Siblings provide anticipatory socialization.** Siblings represented the most potent source of anticipatory socialization experiences for participants with regard to what to expect in their collegiate experience. For example, Ian, a junior mechanical engineering stayer at HCU, described how his brother helped him to become acclimated to campus life:

> My brother told me all the tricks of the trade about campus. He told me it was really good to get involved, and not really because you want to know a lot of people, but because being involved it, it just helps you grow. My brother...pretty much tried to better me. He said, don't do this, don't make the same mistakes as I did, you know. If you need help, you should go ask for help. You know, that's why the professors are there, you know. That's why the tutoring center on campus are there.[Stayer, Junior, HCU]

Older siblings indicated that they spent considerable time preparing their younger siblings for college. Slim, a senior in health administration policy at HCU and engineering leaver, described conversations with his younger siblings:

> [I tell my siblings] just definitely be prepared for long nights, to work hard. College is not the same as high school, especially if you go to a university like this one. I frequently talk to my sister, she's the one that's about to go straight to college now. She's going to be in college, and I frequently talk to her and tell her, 'you know, don't be afraid to go get help.' [Leaver, Senior, HCU]

In addition to providing direct advice, siblings provided students with aspirational goals. These goals represent anticipatory socialization about the worth of professional

careers. In turn, as theorized by Tinto and Pusser (2006) and Beasley (2011), the value that students place on a particular professional career influences students' desire to remain in their chosen program of study. An example of anticipatory socialization regarding the worth of careers was described by AW, a senior in computer engineering at CSU:

> My brother was a computer scientist, he graduated from CSU with a computer science degree and he's got a nice job, nice house in the West End. I want that as well. I want to do something even better with my career. [Stayer, Senior, CSU]

Even if students did not speak directly with their siblings regarding the college experience, students found that observing older siblings' experiences was beneficial. Jerry, a junior in computer science at CSU, explained how observing his siblings affected his college experience: "my brother, who played football at [Large Historically Black College or University (HBCU)] for a scholarship and my sister went to [Other HBCU]...just knowing their experiences, what to do and what not to do, I was in a great position." [Stayer, Junior, CSU]

Siblings, due to their proximity in age and in experience to the participants, can provide useful information about the college experience. Siblings' advice tends to be concrete and actionable. In addition, siblings can provide aspirational goals for current students. These goals, in turn, may provide motivation for a student to complete their education. Overall, the participants indicated that their experiences with siblings provided examples that eased their transition from high school to college.

**Parents as poor source of anticipatory socialization.** Guidance and counsel given by siblings contrasts with that given by parents. Even when parents had attended college, their advice was often unspecific and rarely actionable for students. That is, the participants

indicated that they could not apply parental advice directly to their situation as a college student. Lupe, a junior in computer engineering at HCU, summarized his parents' advice regarding obtaining academic assistance in college: "they wouldn't really know a lot about going about helping me...I just tell them what I'm going through and they say just keep faith, talk to professors. 'Someone's done this before'." [Stayer, Junior, HCU] James Franco, a sophomore in mechanical engineering at HCU, further emphasized Lupe's view that although parents are trying to be supportive, their advice is often not specific enough to provide assistance for students struggling with academics:

> My dad always talks to me about how I'm doing in school but he can't say, 'oh, if you're in dynamics, then maybe go to your next year's fluid mechanics because it's based on the same thing, and you know, they can help you.' So, look for someone in the same subdiscipline, he can't tell me that. He can tell me, 'utilize your resources,' but sometimes, I'm like 'what are my resources?' How do I even know what my resources are? [Stayer, Sophomore, HCU]

David, a senior in chemical engineering at CSU, indicated that asking for advice from his mother was problematic for two reasons: her lack of experience with his situation, and the fact that she did not major in engineering:

> My brother is actually a first generational college student. Then my mom graduated not too long after him, so now I'd be considered second generation. So there's really no point, you know, in asking my mom, because you know, she just got through it. And her college experience is a lot different than mine. Of course, also having a different major will change your college experience altogether. [Stayer, Senior, CSU]

Alex Smith, a senior in mechanical engineering at HCU, also emphasized the difficulty that parents have in providing specific advice regarding engineering school. Even though Alex's father was an engineer, Alex felt that the time gap between parental and student college attendance skewed parental perceptions of college, and made their advice of limited usefulness:

> Parents aren't too specific, they are just like 'go to school, be good, do your best.' It's not helping, because parents, of course they care, but there is only so much that they can actually advise you on when it comes to the actual – not the book work – the actual curriculum, the courses. [Stayer, Senior, HCU]

Given the unspecific nature of parental advice regarding college and careers, students were forced to obtain information about how to navigate the college environment in other ways. For some participants, that meant experientially learning the successful habits associated with college, with concomitant delays in academic performance. For others, it meant relying on college peers and organizations to help with the adjustment required of a new college student. However, the formation of support groups for students was confounded by the relative isolation experienced by African Americans in engineering majors.

**African American Isolation in Engineering Programs**

Tinto and Pusser's (2006) model emphasized the need for student involvement to encourage student retention. The small percentage of African Americans students enrolled in engineering may impede these students' ability to form a supportive community. The ability of students to form community within a majority White environment appeared to be influenced by students' anticipatory socialization experiences. The students I interviewed who had previous

experience in majority White environments indicated that they were better able to form the community needed for collegiate success and thereby avoid isolation.

Despite being greatly outnumbered racially in their engineering programs, some students I interviewed indicated that they did not feel isolated and were able to form community. These participants developed strategies to prevent their isolation prior to college. Therefore, students felt as if their anticipatory socialization experiences as a racial minority prepared them for engineering school and allowed them to adjust to their limited representation. For example, students who attended majority White high schools felt that this experience prepared them for their majority White engineering school. Abraham, a current mechanical engineering major at CSU, related how he felt prepared for the racial make-up of engineering school by his experiences at a Governor's high school[7]:

> I can see an African American student, outnumbered, feeling isolated and feeling lower than the majority. I am where I am today because of growth, and experience, because when I first went to Governor's school, [I came from] a predominantly Black school. When I went to Governor's school it was mixed, but predominantly White and also, these people are of a higher socio-economic class...and their academic climate was a lot higher. So when I would be in class, sometimes I would be scared to answer questions, because I didn't want to sound stupid. It was hard for me to interact with them, because I felt like they were just at a different level, but as I grew older, and matured, I became more confident [and] aware of my abilities.[Stayer, Did not answer, CSU]

[7] "Governor's Schools give gifted students academic and visual and performing arts opportunities beyond those normally available in the students' home schools."(VDOE, 2014)

Aaron, an engineering leaver who graduated from HCU, detailed how his participation in predominantly White summer camps prepared him for the experience of being in the minority in college:

> When I came here [to] my student orientation, I was the only Black male in my orientation. I ain't lying. My orientation was over 100 people, and there was one other Black girl, and I just remember sitting there thinking, 'oh my gosh.' It didn't bother me because [while] my school was predominantly Black and Hispanic, I used to go to YMCA camps when I was younger, and I was the only Black kid there. I used to go to these camps in the summer, so I didn't have culture shock, because I was already introduced to Caucasian people [as] the only Black guy in a lot of situations when I was younger. So I didn't have an issue, or anything like that. But, I think for some people, if they are coming from areas that they don't see a lot of White people, or they haven't interacted with them, sometimes they have culture shock. [Leaver, Graduate, HCU]

James Franco, a current mechanical engineering major at HCU, described how unfamiliarity with a majority White environment due to a lack of anticipatory socialization contributed to student isolation, and in turn prevented students from seeking academic assistance:

> I know a lot of African Americans that are either foreign exchange students from Africa or they went to predominantly Black high schools. Then they get into a class, a mechanical engineering class, and they look around, and it's not predominantly Black anymore. And they don't really know who to go to. The teachers aren't Black, the other kids aren't Black, and they really don't know who to go to. [Stayer, Sophomore, HCU]

David, a chemical engineering stayer at CSU, recalled that despite conversations with his father, he still had to experience the racial isolation of the engineering department in order to develop coping strategies:

> I remember my dad telling me a long time ago that engineering is a predominantly White male career. So there's really not a lot of diversity there at all, and then when you only have two Black people, two [Black] males in the classroom...It can get kind of tough because college is supposed to be a dress rehearsal for the real world, but it is still supposed to be a safe protected environment. But you learn early on the difference between those who are more privileged to get where they need to go, and those not quite so much. You learn that early on within a college career. So it takes away that naiveness, like, 'oh, I'm not in high school anymore.' This is real, I mean, I understand it is not the real world, but it's still reality, that there are going to be more White males doing this than Black people in general. And you kind of have that me against the world mentality from day one because now you're trying to go against the statistics that have been true for so long. [Stayer, Senior, CSU]

Finally, a lack of African Americans in engineering programs contributes to the anticipatory socialization of students in a negative manner. Because students do not see other African American students graduating with a degree in engineering , they wonder if they themselves can be successful. Abraham, a mechanical engineering major at CSU, reported similar observations of the racial make-up of his engineering classes. In addition, Abraham wondered about the reasons for racial disparity in engineering:

> I think that you know, as an African American male, I've noticed the distribution amongst the engineering students in the department. You know, mainly, obviously the

> White/Middle Eastern students, or of Middle Eastern descent, they outweigh the African American [students] exponentially. You know, there's been times when I've been the only African American in my class, and, me, myself, I sometimes wonder, does it have something to do with upbringing, socioeconomic class? Is there like this inherent determination that African Americans lack that discourages from the major? [Stayer, Did not answer, CSU]

For many students, transition to college means the dissolution of the community formed during their high school years. Students must form a new community for support and advice. For African American engineering students, this may mean negotiating a predominantly White environment. For those students faced with the prospect of an unfamiliar environment, anticipatory socialization experiences provide strategies for the student to develop community and lessen isolation.

**Developing a Connection to the College Community**

Students felt that their membership in both professional organizations and extracurricular clubs improved their collegiate experience. For example, membership in organizations provided emotional and academic support for participants, who may have otherwise faced isolation as one of the few African Americans in an engineering program. These sentiments support Tinto and Pusser's (2006) proposals regarding the role of campus involvement in student retention. Extracurricular memberships provided students with both a sense of community and a place to receive academic support. All participants were in some way involved in extracurricular activities; however, not all were involved in extracurricular activities germane to their major. Students chose to join professional organizations and clubs based primarily on recommendations from friends while at college, rather than from

anticipatory socialization. In addition, HCU students indicated the importance of the extracurricular connections formed as a result of participation in a summer bridge program.

**The Importance of The National Society of Black Engineers (NSBE).** Although participants were members of many extracurricular organizations, engineering students from both schools indicated that the majority of their support, both academic and social, came from membership in NSBE. Students who were members of NSBE experienced a variety of benefits from their membership in this professional organization. Participants who were members of NSBE at some point during their college experience were more likely to have stayed in engineering. NSBE provided participants with a pre-existing community, social supports, and academic supports, all of which contributed to student retention. NSBE is a professional organization of African American engineers and engineering students whose mission is "to increase the number of culturally responsible Black engineers who excel academically, succeed professionally and positively impact the community"(National Society for Black Engineers, 2014).

One of the primary benefits students experienced from their membership in NSBE was a sense of community. David, an engineering stayer at CSU, explained how membership in NSBE helped him feel like part of a larger community at the college:

> [Membership in NSBE is] positive because now you don't feel alone. Like that isolation feeling goes away. Now you actually have people that know exactly what you are going through, or you had someone that knows exactly what you are going through. So it's not like you're going in there by yourself. You actually have a group of people that you can actually share some camaraderie with, some kind of

> understanding or feeling. So now you're in a more positive mood than you were before. [Stayer, Senior, CSU]

James Franco, an engineering stayer at HCU, agreed with David's premise that membership in NSBE was important as it allowed African American students to develop a sense of community within the engineering program:

> That [NSBE is useful for developing a sense of community] is absolutely true. I can name a number of [African American] students that I didn't even know in my classes, mainly because I sit in the front and they sit in towards the back. And I have actually never seen them, and I met them through NSBE and now I study with them. [Stayer, Sophomore, CSU]

A student's ability to form study groups is cited by participants as crucial to success in an engineering program. Study group formation is crucial to maintaining the sense of community that Tinto and Pusser (2006) cite as critical to student retention. In addition, as established earlier in this dissertation, study groups allow students to get the academic assistance they need as they advance in their major and the college provides less support. Participants felt that NSBE provided an important opportunity for students to be able to form study groups. Bob, a junior in mechanical engineering at HCU, also saw membership in NSBE as a means for African American students to participate in an academic community:

> I think it [membership in NSBE] is very important, because I think that is one of the main reasons that organization was put into effect: to create a network for incoming African American engineers. It is important when an incoming freshman comes to school, and they're an engineering major. [Stayer, Junior, HCU]

NSBE provided positive role models for engineering students. In addition, NSBE allowed students to see African Americans succeeding in the engineering workforce, thus providing a means of anticipatory socialization for success in engineering. Students created opportunities for professional networking through their membership in NSBE. Students felt that their membership in NSBE had provided opportunities for internships and other experiences that they otherwise would not have been able to obtain. Jerry, a junior in computer science at CSU, described the types of opportunities and support available as a member of NSBE:

> NSBE is a tremendous support because you get to see – going to [NSBE] conferences, you get to see how many African American engineers are out there. You get to network, [and] networking is huge. I had an internship this past year, another guy had an internship in an area, and we were both touring each other's facility. And you know, I signed up too late, but it was this crazy, because he was actually the one running the tour he just slid me right on the list. So it's a big network. I think you never know where you're going to see these people at. [Stayer, Junior, CSU]

Despite the obvious benefits for students from membership in NSBE, all participants indicated that personal relationships with current organization members was the largest factor in their decision to join. However, three participants, Bob, Ian, and James Franco, also indicated that their pre-collegiate experiences with organizations such as NSBE contributed to their decisions to join. James Franco, an engineering stayer at HCU, emphasized the importance of personal connections for extracurricular recruiting:

> [Personal connections] are 99.999% of the reason why [people join extracurricular organizations]. There are times that, because I used to be the public relations and

> membership chair [for NSBE]. And I would go to different classes, like Engineering 101 classes and stuff like that, and give a five minute presentation at the beginning of the class, trying to get people to come to NSBE. And I have noticed that I got absolutely zero people to come to NSBE, and there were African American students in the classes that were looking at me, watching me present this material, and they just didn't come. Everybody that I know that's come has come because there was someone else that told them to come. I see that all the time, you see flyers for this and you see flyers for that, and...you might not know much about that organization and then probably, it would take more information than just a flyer to actually decide, 'should I be a part of this organization?' You don't know if it is a waste of time, you don't know what the organization is about, and you don't know what they do. [Stayer, Sophomore, HCU]

Bob, a junior in mechanical engineering at HCU, described how a family friend encouraged his membership in NSBE, emphasizing the importance of both personal relationships and anticipatory socialization to organizational membership:

> I'm trying to remember the first person that told me to join NSBE. I think it was one of the students, I think he graduated from here, or might still be here. He was in NSBE, and I think he might have been either president or vice-president at one time. He was like, 'every Black engineer should be in NSBE.' So that's how I got involved in NSBE. He also goes to my church, and his family and my family know each other very well...When I was a sophomore in high school, I came up and saw him one time, and went to some of his classes, spent a night, and saw how engineers study and interact with each other. [Stayer, Junior, HCU]

Bob's experience encompasses both the role that personal connections play in student motivation to join extracurricular activities and the role of anticipatory socialization in preparing a student for college. Without Bob's pre-collegiate conversations regarding the importance of extracurricular engagement, he would have been less likely to commit to membership. Ian, a junior in mechanical engineering at HCU, further emphasized the role that anticipatory socialization played in his decision to join NSBE:

> I was in NSBE in high school. I was in the junior NSBE chapter, my parents had signed me up for that, just because my brother was in it. He was in the chapter at HCU, so [my parents said], 'your brother is doing it, why not?' [Stayer, Junior, HCU]

Students were more likely to mention friends or relatives as influential in convincing them of the benefits of joining extracurricular activities, rather than recruitment activities undertaken by the college.

NSBE represents a powerful means to provide students with an academic support group. However, as with other beneficial elements of the collegiate environment, students must be aware of the benefits of the organization before they will choose to join. The college can promote membership in societies like NSBE, but students are more likely to choose to join an extra-curricular organization based on either anticipatory socialization or personal contacts.

**Deliberate and successful anticipatory socialization: The HCU Preparatory Program.** The HCU Preparatory Program was developed to provide financial aid and mentoring for African American students who are interested in pursuing Ph.D. degrees in

STEM (HCU, 2014)[8]. To be eligible for participation in this program, students must be nominated by high school personnel and have strong academic record (HCU, 2014). The HCU Preparatory Program provides intense mentoring, tutoring, and advising to increase the number of African American students completing STEM degrees. In addition, the HCU Preparatory Program immerses students in the collegiate environment through the use of a summer bridge program, where members of the HCU Preparatory Program take college courses prior to their first fall semester enrollment. During the summer bridge program, HCU students are specifically instructed in "time management, problem-solving, and study skills" (HCU, 2014). All of the HCU students interviewed who indicated that they were staying in engineering were participants in the HCU Preparatory Program. All of the HCU students interviewed who chose to leave engineering were not members of the HCU Preparatory Program. Students who participated in the HCU Preparatory Program felt that it was instrumental to their success as an engineering student. Students who were not participants in the program felt excluded from the benefits afforded to members of the program, and this sense of exclusion may have contributed to their decision to leave engineering.

One of the benefits of membership in the HCU Preparatory Program is the anticipatory socialization provided by older members of the program to incoming students. This socialization introduced newcomers to the behavioral norms of students in the engineering program. In particular, students were prepared for the difficulty of engineering, and provided with realistic expectations for their college grades. James Franco, a sophomore in mechanical engineering, described how the HCU Preparatory Program prepared him to expect the difficulty and lower grades associated with studying engineering:

[8] To maintain school pseudonyms, I have changed the name of the program and modified quotations from the school used to describe the program.

> When you're going through mechanical engineering, you're talking to people in your class and they're like, 'dude I just can't do this, this is just really hard.' But when you talk to people that are older [and] have gone through it [they can tell you], 'no man, this is easy. So that was a weed out class.' And [these older students] can give you insights on stuff where you're like, 'what, so he does this every year?' Then you talk about teachers and talk about what the future is like in mechanical engineering, which you can't really see if you are talking to people that are in it currently. And that has been a huge, especially with the HCU Preparatory Program and NSBE, because both of them have older mechanical engineers that I can talk to, and they'll be like 'oh yeah, don't take this professor, take this professor, and yeah, he did this. You probably failed, didn't you? Yeah, we all did, and here's what's going to happen.' [Stayer, Sophomore, HCU]

Contact with older students who had been through the program provided not only anticipatory socialization, but also tangible benefits. Lupe, a junior in mechanical engineering, explained that the HCU Preparatory Program provided more than advice and guidance:

> In the HCU Preparatory Program we always have connections with people that are older than us. The juniors would help the freshmen. Seniors would help sophomores...But I always have a good amount of people within my major to talk to, to say 'hey do you have books from this class, or do you have any advice on [which professor] I should take?' I always know what professor to take when the opportunity arises. [Stayer, Junior, HCU]

Interaction with older students was not the only means by which participation in the HCU Program provided anticipatory socialization for students. During the summer bridge

portion of the program, students were provided with a structured, condensed version of the environment they would have to endure to complete their engineering degree. Participants in the summer bridge program were immersed in an authentic environment, yet provided with additional support beyond that provided to a typical college freshman. Bob, a junior in mechanical engineering, felt that this experience prepared him for his studies as an engineer:

> We took two classes [during the summer bridge program], and it was intense studying and preparing; losing sleep and making sacrifices, and that experience prepared me for my four years here. Because that experience basically got everybody used to what college life was going to be about for the next four years. So that was the one thing that I appreciate now that I didn't appreciate then. But I appreciate it now, because I feel like once you go through those six weeks, and you get out of it, you feel prepared for anything. [Stayer, Junior, HCU]

Only participants in the HCU Preparatory Program received the benefits of the summer bridge program. All students I interviewed who did not participate in the HCU program switched majors from engineering, and students who did not participate appeared to be at a disadvantage compared to those students involved in the program.

Ian, a junior in mechanical engineering and a participant in the HCU Preparatory Program, described the sense of exclusion and disadvantage felt by his classmates that were not part of the program:

> A lot of the people that I associated with my freshman year, that's something that I felt strongly from them that they felt disadvantaged. They felt like the HCU Preparatory Program participants got everything, and they felt like the participants had an advantage. We were seen as smarter, and we were seen as [being] given more opportunities than

> them. [Not participating in the program] put that precedent in them that 'we're behind, we're not taking advantage of resources, we need to study more, we're not as talented.' So that's something negative that I saw that people would put on themselves. [Stayer, Junior, HCU]

Aaron, a graduate of the graphic design program, engineering leaver, and not a participant in the HCU Preparatory Program, explained the disadvantages that he felt comparing his academic situation to the situation of students who were program members:

> I have friends that were in the HCU Preparatory Program. In some ways, my friends were slightly discouraging, and it was because they were so far along. I remember, I had a friend who went to my high school. I wasn't really good friends with him while I was in high school, but when I got here, we definitely became friends because he was a familiar face. And he was in the same program as me, but he was steps ahead. He was three, four classes ahead of me before I started. So I remember thinking, 'whoa.' And I remember thinking, this is a five-year major, and I don't even want to be here. And then I would [think] I'm all right, I'm going to do it, and then he would talk to me. He'd be like, 'yeah, this is the classes I'm taking right now'. And I would look at the math he was taking, and I would think, I don't know what's going on. [Leaver, Graduate, HCU]

In addition to feeling behind academically as a result of not participating in the HCU Preparatory Program, some students who did not participate in the program felt excluded by program members. This exclusionary behavior was mentioned by some members of the HCU Preparatory Program. Alex Smith, a senior in mechanical engineering, and an HCU

Preparatory Program member, indicated that program members tended to exclude non-members:

> Let's put it this way; the older program members, very rarely do they have study groups for everyone. They have study groups just for program members, you know what I mean? Unless the young program members bring their friends...[Stayer, Senior, HCU]

James Franco, a sophomore in mechanical engineering, and an HCU Preparatory Program participant, agreed with Alex Smith, stating, "there are some groups within the HCU Preparatory Program that do tend to keep to themselves."[Stayer, Sophomore, HCU] However, not all students who did not participate in the HCU Preparatory Program felt excluded. Timothy James, a senior in financial economics, indicated that he did not feel left behind academically by students who were involved in the program:

> I was in all of the same classes as they [HCU Preparatory Program students] were. So I didn't really feel left behind. Because I tested into a lot of the classes that they were taking as well. And coming from high school, I knew one person in the HCU Preparatory Program. That's how I made friends in the HCU Preparatory Program. [Leaver, Senior, HCU]

Although Timothy did not feel excluded by the HCU Preparatory Program members, he did not receive either the support or the anticipatory socialization afforded to program participants. Timothy did choose to leave engineering after failing to pass a gateway class. Perhaps the additional support and preparation given to the HCU Preparatory Program students would have encouraged Timothy to remain in engineering.

**Summary of the Data**

The data supported many aspects of the theoretical framework used for this dissertation study, including the role of anticipatory socialization and aspects of Tinto and Pusser's (2006) model for student retention. The students I interviewed confirmed that anticipatory socialization was an important way to ease their transition to the college engineering environment. Similarly, the students that I interviewed substantiated the importance of community to student retention as proposed by Tinto and Pusser (2006). That said, apart from the experiences of students in the HCU Preparatory Program, the anticipatory socialization experiences of students who chose to depart and students who chose to stay in engineering were similar.

Twenty out of 21 participants felt that they were unprepared for college in many ways. Primarily, the participants felt that the study and time management skills that they possessed when entering college were insufficient to meet the requirements of pursuing an engineering degree. As a result, the students I interviewed either were taught skills by the college through specific interventions, such as the HCU Preparatory Program, or were forced to learn these skills through trial and error. Both the students who stayed in engineering and students who left engineering indicated that they were unprepared for the college engineering environment, and that their anticipatory socialization experiences in high school failed to prepare them for the college academic and social environment.

The participants felt that high school was insufficiently challenging for students and thus failed to make them understand the academic difficulty they would encounter in college. All of the participants also felt that high school anticipatorily socialized them to not need academic assistance, such as tutoring. This expectation that engineering students not require

academic assistance was unrealistic, and students were forced to re-examine their behaviors after receiving grades that did not meet their expectations. In addition, students felt that the intellectual level of high school classes did not prepare them for the critical thinking skills required for success in an engineering environment.

The interview data revealed that parents provided support and advice regarding college; however, the anticipatory socialization provided by parents regarding the college environment was not specific enough to help students improve their academic performance. For example, parents told children to work harder, and seek help, but did not specify how they could "work harder," or where they could seek help. Another finding revealed from the interviews was the significance of college attending older siblings in providing anticipatory socialization. Conversations with siblings assisted students navigating the college environment. Participants with older college attending siblings, irrespective of the siblings' major, received meaningful anticipatory socialization about how to succeed in college. Likewise, participants with younger siblings generally discussed the collegiate environment with these siblings and provided useful information about behavioral norms that would allow the younger student to succeed.

The interviews with the study's participants also indicated the importance of academic support to completing the engineering degree. Specifically, students received academic assistance through the formation of peer support groups. Students also created support groups through their membership in professional organizations and other extracurricular activities. In addition, students received academic assistance through formal college programs, such as tutoring, supplementary instruction, and instructors' office hours as previously mentioned. However, as the intensity and difficulty of the courses increased, the availability of college-

provided assistance decreased. Finally, participants discussed the role that personal pride played in preventing students from seeking or accepting academic assistance from the college and from peers.

The sole difference, as reported by participants, in anticipatory socialization between students who stayed and those who departed from engineering was participation in the HCU Preparatory Program. The HCU Preparatory Program is a support program that provides mentoring, tutoring, and other academic services to STEM students, thus providing college sponsored anticipatory socialization with regard to the college engineering environment. Students felt that their membership in the HCU Preparatory Program was instrumental in their success in engineering, because it provided the study skills and mindset students needed for academic success in engineering. In contrast, non-membership in the HCU Preparatory Program created a sense of exclusion that discouraged students from remaining in engineering.

## Chapter Five: Conclusions and Implications

The purpose of this dissertation study was to determine the differences in anticipatory socialization experiences between students who chose to stay in an undergraduate engineering program and students who chose to leave. To that end, I interviewed current and former engineering students to understand how their pre-collegiate experiences prepared them to adapt to the college engineering environment, in particular how pre-collegiate experiences shaped student attitudes towards forming community and seeking academic assistance.

In this chapter, I discuss how differences in students' pre-collegiate experiences influenced student decisions regarding whether to stay or depart from engineering. In addition, this chapter reviews the similarities in the pre-collegiate experiences of all the participants and how these experiences interacted with elements of Tinto and Pusser's (2006) model of student departure. Afterwards, I discuss the contributions of this dissertation to the literature, specifically the importance of anticipatory socialization to student preparation for college, support for Tinto and Pusser's (2006) model for institutional action, and methodological contributions to the literature regarding engineering school attrition. I conclude by offering recommendations for both policy changes and future research regarding engineering attrition based on this study's findings.

### Differences in Anticipatory Socialization between Those Who Stay and Those Who Depart

The research question guiding this dissertation was: In what ways does the anticipatory socialization of male African American students who chose to remain in a collegiate engineering program differ from the anticipatory socialization of male African American students who depart from these programs? The data from the ethnographic interviews suggested that the pre-collegiate experience that had the most impact on HCU student engineering persistence or

departure was the students' experiences in a summer bridge program, the HCU Preparatory Program.

Students enrolled in the HCU Preparatory Program were provided with substantial support in the form of a pre-established community. In addition, participation in the summer bridge program emphasized the importance of seeking academic assistance by providing not only information on where to find academic help but also encouragement to seek such help. As a result, students who participated in the summer bridge portion of the HCU Preparatory program arrived at their first semester of college with a sense of community and the requisite resources to obtain academic assistance. Conversely, non-participation in the HCU Preparatory Program excluded students socially, and this lack of social integration discouraged them from finding community within their own major. In addition, students who did not participate in the HCU Preparatory Program were less likely to seek academic assistance. Participants in the HCU Preparatory Program felt that the program was instrumental in their choice to remain in engineering in that it prepared them socially for the college environment[9].

The HCU Preparatory Program created an intentional community of future engineers through the summer bridge portion of the program by providing students with strong anticipatory socialization experiences. For example, incoming engineering students in the HCU Preparatory Program experienced the rigors of the engineering program first hand, and were exposed to the volume of work necessary to succeed in engineering while taking their introductory engineering classes during the summer bridge portion of the program. Participating students worked late nights and held group study sessions, with additional support provided by older engineering

[9] Participation in the HCU Preparatory program was voluntary. Students were nominated for participation in the program based on a recommendation from members of their high school administration. After nomination, students were selected based on grades, standardized test scores, personal essay, and demonstrated commitment to serving the community.

students. These older and more experienced engineering students provided the incoming engineering students with social support that eased the new students' transition into their new environment. In addition, during the summer bridge portion of the program, HCU Preparatory students were enculturated to seek and form study groups throughout their tenure at the university. In fact, the study participants indicated that the formation of such study groups was a crucial element of engineering student success. Bolstering the critical social supports provided by group membership, the anticipatory socialization experienced by HCU Preparatory Program participants created the expectation in participants that they would seek academic assistance from the college routinely. In the HCU Preparatory Program, HCU has created an intentional community and provided time for this community to formally and informally instill the unwritten rules of engineering success in new students, such as the importance of academic help seeking behaviors to engineering student success.

The contrast between students who participated in the HCU Preparatory Program and those who did not was significant. For instance, students in the program indicated a clear sense of community and spoke of their reliance on the program for guidance and support. Conversely, non-participants felt a clear exclusion from the program, and thus from the engineering community at the university in general. Ironically, HCU, in creating this program, has either intentionally or unintentionally created an "out" group: those students who did not participate in the Preparatory Program. The fact that these students see themselves as apart from the "successful" members of the Preparatory Program may further serve to push students away from engineering.

Apart from the anticipatory socialization experienced by students in the HCU Preparatory Program, the pre-collegiate experiences of the students I interviewed were noteworthy in their

similarity. In particular, all of the participants remarked how their high school experiences gave them false expectations regarding the nature and quantity of work required of an engineering student. For example, the students I interviewed generally received good grades in high school despite minimal class preparation. In addition, although participants in this dissertation study came from diverse socioeconomic and educational backgrounds, they all felt that their parents were unable to provide them with actionable advice regarding how to study, how to form community within the college environment, and how to ask for and receive academic assistance. Instead, students primarily relied on their siblings for such advice.

**Similarities in Anticipatory Socialization Experiences of Engineering and Former Engineering Students**

The anticipatory socialization experiences of the participants in this dissertation study were remarkably similar. In particular, participants' high school experiences neither exemplified the quantity and nature of the work required in college nor accurately portrayed the collegiate social environment. In other words, high school was too easy, and emphasized individual effort over group participation, which contrasted with engineering school's expectations. Additionally, participants conveyed that their parents were unable to prepare them socially for the college experience. As a result of the lack of anticipatory socialization experiences providing students with the skills to succeed in engineering, the students I interviewed who did not participate in the summer bridge portion of the HCU Preparatory Program were forced to develop strategies to cope with the college environment concomitantly with their enrollment.

**Criticism of the high school experience.** With one exception, the students I interviewed for this dissertation study were highly critical of their high school experiences' failure to prepare them socially for college. For example, interviewees indicated that their high schools did not

provide the opportunity to develop the requisite skills, habits, and educational values traditionally associated with college success, and, in particular, success as an engineering major. Merton (1968) defines anticipatory socialization as a means of transmitting the values required for success in a new role prior to the adoption of that role. The fact that participants' high schools did not anticipatorily socialize students to adapt to the college environment is due to substantial differences in the values traditionally associated with high school success and those values required for success as an engineering major, such as study skills and the need for academic assistance. For the interviewees, high school's academic simplicity and focus on individual achievement were impediments to the students' adjustment to the college engineering environment. The actions that students took to succeed in high school were not applicable to college.

The participants completed high school with a minimal amount of academic effort yet earned good grades. For example, the interviewees recalled preparing for high school classes five minutes before the bell, often completing homework in the hallway, and yet graduating with high academic GPAs. These experiences led participants to expect similar circumstances in college; that is, that they could expect to be academically successful with a limited amount of class preparation. Theoretically, high school was to prepare the students I interviewed their future by assisting them with their choice of career, and academic collegiate success. However, high school provided students a sense of academic achievement yet failed to provide realistic preparation for the college engineering experience. In this way, high school enculturated students to expect positive academic outcomes without the concomitant work. Paradoxically, participants' success in high school had a negative effect on their studies in college.

The ease with which participants completed high school academics affected their willingness to seek academic assistance in college. That is, because high school was easy for the interviewees, the students I interviewed developed a sense of pride in their achievement, which in turn caused a mismatch between the difficulties students faced in engineering and their self-image as a successful student. Thus, asking for and receiving academic assistance was difficult for the interviewees as such requests were incongruent with these students' self-image.

The level of analytical skills required for high school success failed to prepare students for that required of engineering students. For the participants, high school assessment and instruction focused on memorization and repetition, and thus the interviewees developed the requisite skills needed to succeed academically in that venue. I speculate that high school's emphasis on memorization may be resultant from the high-stakes testing movement in the public schools. As student, and in turn teacher, performance is measured based on multiple-choice, mass administered tests, it is perhaps not surprising that these are the skills that students arrive to college with, rather than the critical thinking skills required of engineering students. In contrast to their high school experience, participants indicated that as engineering majors their performance was assessed based on their application, analysis, and synthesis of knowledge. Students arrived at college without appropriate skills, and had to learn these skills while struggling to succeed with their engineering classwork.

Finally, the focus of the high school classroom on individual achievement failed to prepare participants for the group nature of much of the work in college. The interviewees repeatedly indicated that success in engineering school required group work. In addition, much of the literature regarding college attrition (e.g. Astin, 1984; Tinto & Pusser, 2006) indicated that a student's ability to form community within the college setting leads to increased retention. The

lack of group work experienced by the participants in high school caused students to devalue groups, and required them to readjust their values upon arrival at college.

Slim, an engineering leaver at HCU, attended a technical high school, and his high school and subsequent college experience was substantially different from the other participants. Slim felt that his high school experience had adequately demonstrated and reinforced the behaviors and values necessary for success in engineering school. However, Slim's experience cannot be generalized. Researchers have done little work to understand the effects of STEM specialized schools on student STEM major retention (Almarode, et al., 2014; National Research Council, 2011). Research regarding STEM high schools has focused on choice of undergraduate major, rather than on the retention of these students (Almarode, et al., 2014; Subotnik et al., 2010). In addition, STEM specialty schools have widely different programs (Scott, 2012). I suggest that further research on the effect of elements of STEM specialty high schools is needed to understand the components of these high schools that may contribute to student college retention.

I do not see Slim's experience as an endorsement of specialized schools. Rather, given the diversity of the types of experiences inherent in specialized schools, I see Slim's experience as a point for future research. Simply changing the subject matter of the high school experience, while leaving other aspects intact, will not result in reducing attrition for engineering students. Rather, I propose that all high schools must examine the messages that they are sending students about achievement, and how these messages are affecting students in their college lives. If a student has been successful all through high school by exerting a minimum of effort, they are unlikely to be prepared for the work and mindset required of a successful college student.

**Lack of anticipatory socialization from parents.** Twenty of the 21 students I interviewed felt that their parents did not provide appropriate guidance or useful counsel about

the college experience, regardless of the parents' experience, or lack thereof, regarding college. Participants felt that parental advice was too non-specific to be actionable, consisting of platitudes such as "do your best" or "try harder." In addition, students felt that their parents did not necessarily understand or appreciate either the current climate of higher education or the students' chosen major. Parents could not provide input as to which courses students should take, how students could receive academic assistance from the college, or what campus resources were available to the students. These findings in some ways replicated those of Beasley (2011), who determined that African American parents, regardless of socio-economic status, are unable to provide guidance to students regarding their choices in college. However, the parents of the students I interviewed were unable to provide advice not only about choices, but also about how to navigate the college experience in general, and the engineering student experience in particular.

In contrast to the advice provided by parents, I found that siblings played an important role in preparing students for college in general and the engineering environment in particular. Older siblings provided the study participants with actionable knowledge, attitudes, and values regarding college. For example, older siblings told the interviewees what campus organizations to join, and how to leverage membership in these academic organizations for academic success. Older siblings provided participants with advice about which classes to take, which professors to avoid, and how to form community on campus. Students without older siblings experienced a preparatory disadvantage, and were forced to learn about the college environment the "hard way."

I speculate that the importance that the students I interviewed placed on advice from siblings arises from several factors. First, the smaller age difference between the participants and

their older siblings relative to the interviewees' parents provided added relevance to the siblings' message. Second, many of the students were able to actually observe their sibling's interactions with the collegiate environment, which in turn provided a stronger anticipatory socialization experience relative to parental advice regarding the college environment.

**Contribution to the Literature**

This dissertation study contributes to the literature on engineering student departure in four ways. The first contribution is methodological, namely the use of qualitative research methods and case study techniques in particular to examine the phenomenon of engineering student departure. The second is confirmation of the importance of anticipatory socialization as a means of examining student collegiate experiences. The third is support for elements of Tinto and Pusser's (2006) Institutional Model for Student Departure, and the fourth and final contribution of this dissertation is insight into how and why students choose to join extracurricular organizations.

**Methodological contributions.** This dissertation study represents one of the few qualitative studies of the college attrition of engineering majors, and one of even fewer qualitative studies concerned with the departure of African American students from engineering programs (Matusovich, Streveler, & Miller, 2010; Perna & Thomas, 2008). Although authors such as Seymour and Hewitt (1996) have detailed the experiences of STEM students, they have conflated the experiences of students in a wide variety of fields. This dissertation study focused solely on engineering student experience.

In addition, although many studies have used pre-collegiate metrics to attempt to predict the success of incoming engineering students (e.g., Ohland et al., 2011), few studies have attempted to frame engineering departure in terms of social, rather than academic, preparation.

As I posit in this dissertation, it would be difficult to determine whether the students I interviewed would remain in engineering based solely on their standardized test scores and high school GPAs. Participants felt ill-prepared to adopt the habits associated with choosing to remain in engineering. The intentional socialization created by the HCU Preparatory Program allowed students to prepare socially for their new role as an engineering student, and thus encouraged them to remain enrolled in engineering.

**The importance of anticipatory socialization to student knowledge regarding college.** Anticipatory socialization is the adoption of values and behaviors prior to assuming a role (Merton, 1968). As demonstrated by the clear and profound effects of participation in a college program designed to intentionally socialize students to prepare them for the collegiate engineering experience, anticipatory socialization of engineering students appears to assist students with their role transition from high school to college student.

The interviews with participants directly supported the proposition that anticipatory socialization is important for student retention. In describing the difference between the preparation that he received from his high school and from the HCU Preparatory Program, Alex Smith said of the engineering program environment, "it's like, someone can tell you all about war. Then you go to war, you're still going to be shocked, right?" [Stayer, Super Senior, HCU] Likewise, James Franco indicated the importance anticipatory socialization: "I just know a lot of people that changed majors or just decided that they didn't want to do it for some reason or another. And to me it was because I feel like they never had anybody explain to them like this is what you do, this is what you do." [Stayer, Sophomore, HCU] Similarly, John indicated that "I think the biggest struggle is the [engineering school] mindset has to be had before hitting college." [Stayer, Junior, HCU]

The students I interviewed also indicated that they were hampered in their pursuit of an engineering degree by the anticipatory socialization, or lack thereof, of their high school experiences. The participants felt that high school failed to provide examples of the rigor, work ethic, and study and time management skills required to be successful in an engineering program. This feeling of a lack of preparation was the same for both students who stayed in engineering and those who left. Moreover, the students I interviewed felt that they simply did not know what would be expected of them when they entered engineering, and that the high school environment did little to prepare them.

Again, a notable exception to the experiences of the majority of students that underscores the importance of anticipatory socialization is Slim, who attended an engineering high school. As with HCU's Preparatory Program, Slim's high school specifically anticipatorily socialized students to adapt to their eventual college engineering environment. However, Slim did not leave because he felt unprepared. Slim indicated that he left because he realized that he did not want to pursue a career in engineering. In some ways, Slim's high school preparation enabled him to make this decision, as he was one of the few students interviewed who had a complete conception of what the job of an engineer entailed.

**Support for Tinto and Pusser's (2006) model for institutional action.** As I discussed in the theoretical framework for this dissertation, I did not try to capture and examine all elements of the collegiate environment that contribute to student departure. Rather, I chose to examine specific elements of Tinto and Pusser's (2006) model, and the relationship between these college elements and pre-collegiate student experiences. The interviews that I conducted with students supported Tinto and Pusser's (2006) assertions regarding the importance of community in the form of extracurricular organizations, the ability to seek and receive academic

assistance from the college, and the value that students place on the subject matter they have chosen to study.

All of the participants who stayed in engineering indicated that without the academic assistance provided by both the college and peers, they would not have been able to successfully complete their engineering program. I argue that this confirmed Tinto and Pusser's (2006) assertion regarding the importance of academic assistance to student success. However, although participants indicated the importance of academic assistance, they felt that the colleges often failed to provide sufficient assistance, particularly in higher level classes. In addition, some of the students I interviewed felt that although the college provided assistance, obtaining assistance for a student new to the college environment was difficult and confusing. To extend Tinto and Pusser's (2006) argument regarding the importance of academic assistance for students, the college must not only make academic assistance available to students, but also must ensure that students are aware of how to take advantage of the academic assistance afforded to them, such as tutoring centers, professors' office hours, and TA sessions.

Finally, my interviews with students confirmed Tinto and Pusser's (2006) theory regarding the need for students to develop community within the college environment. Participants felt that community allowed them to develop resources, such as study groups, that provided academic assistance. In addition, participants emphasized the importance of membership in professional organizations, in that membership allowed students to develop a sense of community as well as to obtain academic and social assistance.

**The motivation to join extracurricular organizations.** Previous research (e.g. Tinto and Pusser, 2006) indicated that membership in professional organizations such as NSBE increases the likelihood that students will remain in engineering. Originally, I theorized that

anticipatory socialization experiences, such as membership in organizations in high school, may have encouraged students to pursue similar membership in college. However, based on interviews with participants, I determined that students were more likely to choose to join professional societies in college as the result of personal contacts. Despite the efforts of the colleges to encourage students to join these organizations, the majority of students indicated that they chose to pursue membership in an organization like NSBE only after they were apprised of membership's utility by a trusted source.

**Policy Recommendations**

Considering the findings of this dissertation study, I have developed a specific policy recommendation intended to increase the completion rates of African American engineering students. Specifically, both high schools and colleges should develop programs that intentionally socialize students to the college environment in general, and the engineering environment in particular. The participants in this study clearly indicated that they felt inadequately prepared for the experiences of engineering school. The volume of work, the difficulty of the subject matter, and the class requirements of engineering programs were all completely different from the requirements for success in the high school environment. Although students felt academically prepared by high school, that is, they felt that they could successfully complete the coursework required upon entry to engineering school, they did not have either the study or time management skills required for success in engineering school.

High schools and engineering schools share the responsibility for ensuring that students have the skill set required for success in engineering. Rather than simply instructing students regarding the differences between the college and high school learning environment, high schools must take an active role by creating opportunities for students to experience the actual

learning environment of a college. The students I interviewed consistently said that exposure to the actual experience of the college engineering environment was necessary to change behaviors and values. Slim's experience in an engineering high school, and subsequent experiences in a college engineering program, show that high schools can provide the anticipatory socialization necessary for college engineering programs. To do so, high schools must emphasize teamwork and the need to seek and utilize academic assistance in college. In addition, high schools should consider revising their curricula to more closely mimic the college environment. With the exception of Slim, the high school experience of the dissertation participants was mostly repetition and memorization, with little application of knowledge. A revised high school curriculum, with an increase in critical thinking skills and application of knowledge, would serve to prepare students more meaningfully for their college experience. The lack of such a challenging curriculum led study participants to feel ill prepared with regard to study and time management skills when they arrived at college. Although Slim chose to leave engineering, he did so as a result of changing his career choice, rather than out of an ability to adopt the values and habits required for success in engineering school.

Unfortunately, researchers have yet to perform extended study of how specialized schools, such as engineering schools, affect student retention in college (Almarode, et al., 2014, National Research Council, 2011). Although Almarode and colleagues (2014) found that students who graduated from STEM high schools were more likely to obtain STEM degrees, this study did not compare the attrition rates from college STEM programs between students who attended specialized STEM high schools and those who did not. Almarode and associates (2014) studied the interest generated by specialized high schools rather than the anticipatory socialization experienced by students attending these high schools.

Colleges cannot expect students to inherently know how to navigate the engineering environment. Although many schools require orientation classes to familiarize students with the college environment, the model provided by the HCU Preparatory Program is different. The HCU Preparatory Program provides students with structured experiences designed to acclimate them to the college environment. Rather than simply hearing about what is required of them during an engineering course of study, students live as an engineering student, albeit with additional supports. These experiences appear to increase student retention.

However, opportunities such as the HCU Preparatory Program must be made available to all students, rather than a select group. For the students I interviewed, the HCU Preparatory Program created an exclusionary environment for those students not selected for membership. As a consequence, students who did not participate in the summer bridge and other aspects of the HCU Preparatory Program felt as if they were behind their peers. In addition, the HCU Preparatory Program contributed to a lack of community among students who did not participate, further decreasing the chances that students who were not members of this elite group would complete their engineering studies.

Finally, this dissertation study shows the importance of siblings to acclimating students to the college environment in general and the engineering environment in particular. Schools should examine recruitment and retention policies that incorporate the inclusion of the whole family, rather than focusing solely on parents and prospective students. Older siblings can prove to be a powerful source of anticipatory socialization that can acclimate their younger siblings to the college environment. Engineering colleges can utilize the impact of an older sibling's experience to acclimate students to the college environment.

**Future Research**

During the interviews for this dissertation, participants spoke of many challenges encountered in the college engineering environment, and how their experiences had shaped their response to these challenges. Several themes that emerged from a review of the transcripts provided limited data from which to draw conclusions; however, these themes may provide interesting avenues for further research.

**The specific role of NSBE in supporting African American engineering students.** Researchers have not addressed NSBE's role specifically in supporting African American engineering students. Rather, authors have postulated that professional organizations "such as NSBE" contribute to positive student outcomes (e.g. Chang, Sharkness, Hurtado & Newman, 2014). Based on this lack of specificity, I propose a study of collegiate NSBE alumni who successfully completed their engineering degrees. Such a study will serve to indicate which elements of NSBE membership contribute to engineering student retention, and may perhaps serve as a model with which to examine other campus organizations. In addition, a study regarding why students choose to join NSBE could provide campus organizations with additional means to recruit students. Such a study could reveal what elements of NSBE allowed members to develop the social networks necessary for success in studying engineering. Finally, this study could contribute to the literature regarding how African American students rely on social networks to discover internships and other job opportunities.

**Comparison between White and African American engineering student anticipatory socialization experiences.** Because I could find few works regarding the anticipatory socialization of engineering students, I was unable to contrast the pre-collegiate experiences of White and African American students. Thus, interpreting the isolation inherent in the nature of

the engineering environment was difficult. Given my status as an outsider, as discussed in the limitations section of this dissertation study, some participants may have withheld information regarding racial isolation in engineering programs. However, based on my conversations with participants, I suspect that racial minority status is only one factor leading to the isolation of engineering students. Although a student's status as a racial minority may contribute to the student's inability to form community, some interviewees mentioned that their isolation was related more to the personality of their fellow engineering students. Conducting a similar study of the anticipatory socialization experiences of engineering students as a whole, and White, East-Asian, and Asian students in particular, may provide additional insight into the role race plays in engineering student attrition. For example, do White and Asian students receive the same messages that African American students receive regarding the importance of asking for academic assistance? In addition, such a study could shed light on the differences among the anticipatory socialization experiences of White, African American, and Asian students, and how these experiences interact with the college environment.

**The role of pride in African American engineering students' achievement and college adjustment.** Another theme that developed during my analysis of interviews was the effect of pride on student campus interactions. Many participants indicated that they were hesitant to ask for help from professors or other students out of a sense of pride. Some participants attributed this sense of pride to their racial isolation. The African American students that I interviewed may not have received academic assistance in the same manner as similarly situated White students, as the African American students may have refrained from asking for help in order not to appear weak or ignorant in front of their White colleagues. I propose that additional research may show how pride affects help seeking behavior in students, and how

colleges may be able to encourage students to obtain academic assistance without affecting their sense of personal pride.

**Conclusions**

The title of this dissertation, "Beyond Academic Preparation," provides an appropriate summary for my conclusions after conducting this research. In general, the students I interviewed were high achieving students in high school who felt that the basic academic skills, such as math, reading, and writing that they possessed upon entry into college were not an impediment to their success in an engineering program. Rather, the participants felt as if their pre-collegiate experiences had failed to adequately prepare them with the values and habits required to succeed in their collegiate experience. In particular, students saw high school as actively creating a false sense of academic accomplishment. Students saw themselves as successful, and expected continued success in the college engineering environment. These expectations of success were in sharp contrast to reality, as the habits and values developed by students through the anticipatory socialization of high school were not applicable to the college engineering environment. In addition, these students, because of their expectations for success, were not used to asking for and receiving academic help. Without academic assistance, success as an engineering undergraduate is unlikely. Finally, high school's emphasis on individual work socialized students to not expect to work in groups. Again, without the formation of groups on campus, for either social or academic support, success in undergraduate engineering programs is unlikely.

The college environment is foreign for a recent high school graduate. The engineering environment within a college is more foreign still, with different expectations. To enable more students to successfully complete a degree in engineering, colleges should provide the intentional

opportunity for students to learn the values and behaviors associated with engineering student success. Anticipatory socialization experiences, such as those afforded by the HCU Preparatory Program, will allow students to prepare themselves socially for the college engineering environment.

References

Aitken, N. D. (1982). College student performance, satisfaction and retention: Specification and estimation of a structural model. *The Journal of Higher Education, 53*, 32-50. doi:10.2307/1981537

Ackerman, T. F. (1989). An ethical framework for the practice of paying research subjects. *IRB: Ethics and Human Research*, 1-4. doi:10.2307/3564170

Almarode, J. T., Subotnik, R. F., Crowe, E., Tai, R. H., Lee, G. M., & Nowlin, F. (2014). Specialized High Schools and Talent Search Programs Incubators for Adolescents With High Ability in STEM Disciplines. *Journal of Advanced Academics, 25*, 307-331. doi:10.1177/1932202X14536566

Alon, S., & Tienda, M. (2005). Assessing the "mismatch" hypothesis: Differences in college graduation rates by institutional selectivity. *Sociology of Education, 78*, 294-315. doi:10.1177/003804070507800402

Amelink, C., & Creamer, E. (2010). Gender differences in elements of the undergraduate experience that influence satisfaction with the engineering major and the intent to pursue engineering as a career. *Journal of Engineering Education (Washington, D.C.), 99*, 81-92. doi:10.1002/j.2168-9830.2010.tb01044.x

Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B., & Wong, B. (2012). Science aspirations, capital, and family habitus: How families shape children's engagement and identification with science. *American Educational Research Journal, 49*, 881-908. doi:10.3102/0002831211433290

Astin, A. W. (1984). Student involvement: A developmental theory for higher education. *Journal of college student personnel, 25*, 297-308.

Astin, A. W., & Oseguera, L. (2005). Pre-college and institutional influences on degree attainment. In A. Seidman (Ed.), *College student retention: A formula for student success* (pp. 119-146). Westport, CT: Praeger Publishers.

Athanasiou, R. (1971). Selection and socialization: A study of engineering student attrition. *Journal of Educational Psychology, 62*, 157-166. doi:10.1037/h0030771

Atkinson, R. (2012). Why the current education reform strategy won't work: To improve innovation and boost the economy, the nation needs a fundamentally new approach to education in science, technology, engineering, and mathematics. *Issues in Science and Technology, 28*, 29.

Attinasi, L. C. (1989). Getting in: Mexican Americans' perceptions of university attendance and the implications for freshman year persistence. *The Journal of Higher Education, 60*, 247-277. doi:10.2307/1982250

Bean, J. P. (1985). Interaction effects based on class level in an explanatory model of college student dropout syndrome. *American Educational Research Journal, 22*, 35-64. doi:10.3102/00028312022001035

Beasley, M. A. (2011). *Opting out: Losing the potential of America's young black elite*. Chicago, IL: University of Chicago Press.

Beilin, H. (1956). The pattern of postponability and its relation to social class mobility. *The Journal of Social Psychology, 44*, 33-48. doi:10.1080/00224545.1956.9921900

Benderly, B. (2012). What scientist shortage? *Columbia Journalism Review, 50*, 19.

Berger, J. B., & Lyon, S. C. (2005). Past to present: A historical look at retention. In A. Seidman (Ed.), *College student retention: Formula for student success* (pp. 1-30). Westport, CT: Praeger Publishers.

Bess, J. L. (1978). Anticipatory socialization of graduate students. *Research in Higher Education, 8*, 289-317. doi:10.1007/BF00976801

Besterfield-Sacre, M. (2001). Gender and ethnicity differences in freshmen engineering student attitudes: A cross-institutional study. *Journal of Engineering Education (Washington, D.C.), 90*, 477-489. doi:10.1002/j.2168-9830.2001.tb00629.x

Bloom, Benjamin S. & David R. Krathwohl. (1956). *Taxonomy of educational objectives: The classification of educational goals, by a committee of college and university examiners. Handbook 1: Cognitive domain.* New York, New York: Longmans.

Bonous-Hammarth, M. (2000). Pathways to success: Affirming opportunities for science, mathematics, and engineering majors. *The Journal of Negro Education, 69*, 92-111.

Braxton, J. M., & Hirschy, A. S. (2005). Theoretical developments in the study of college student departure. In A. Seidman (Ed.), *College student retention: Formula for student success* (pp. 61-88). Westport, CT: Praeger Publishers.

Braxton, J. M., Vesper, N., & Hossler, D. (1995). Expectations for college and student persistence. *Research in Higher Education, 36*, 595-612. doi:10.1007/BF02208833

Cabrera, A., Birkum, K. R., & La Nasa, S. M. (2005). Pathways to a four year degree: Determinants of transfer and college completion. In A. Seidman (Ed.), *College student retention: Formula for student success* (pp. 155-214). Westport, CT: Praeger Publishers.

Case, J. (2007). Alienation and engagement: Exploring students' experiences of studying engineering. *Teaching in Higher Education, 12*, 119-133. doi:10.1080/13562510601102354

Cech, E., Rubineau, B., Silbey, S., & Seron, C. (2011). Professional role confidence and gendered persistence in engineering. *American Sociological Review, 76*, 641-666. doi:10.1177/0003122411420815

Chang, M. J., Cerna, O., Han, J., & Saenz, V. (2008). The contradictory roles of institutional status in retaining underrepresented minorities in biomedical and behavioral science majors. *Review of Higher Education, 31*, 433-464.

Chang, M. J., Sharkness, J., Hurtado, S., & Newman, C. B. (2014). What matters in college for retaining aspiring scientists and engineers from underrepresented racial groups. *Journal of Research in Science Teaching, 51*, 555-580. doi: 10.1002/tea.21146

Chimka, J. & Wang, Q. (2009). Accelerated failure-time models of graduation. *Educational Research and Reviews, 4*, 267-271.

Cook, K. (2012). Survey Interviewing. In J.F. Gubrium, J.A. Holstein, A.B. Marvasti, & K. D. McKinney (Eds.), *The Sage handbook of interview research: The complexity of the craft* (pp. 333-344). Thousand Oaks, CA: Sage Publications, Inc.

Creswell, J. (2007). Qualitative inquiry and research design: Choosing among five approaches (2nd ed.). Thousand Oaks, CA: SAGE Publications.

Creswell, J. W., & Miller, D. L. (2000). Determining validity in qualitative inquiry. Theory into practice, 39, 124-130.

Davis, C. E., Yeary, M. B., & Sluss, J. J. (2012). Reversing the trend of engineering enrollment declines with innovative outreach, recruiting, and retention programs. *IEEE Transactions on Education,55*, 157-163. doi:10.1109/TE.2011.2157921

Engineering Workforce Commission of the American Association of Engineering Societies, Inc. (2012). *Engineering and technology enrollments fall 2011.* Reston, VA: American Association of Engineering Societies.

Epstein, D. (2006, July 26). So that's why they're leaving. *Inside Higher Ed.* Retrieved from http://www.insidehighered.com/news/2006/07/26/scipipeline

Epstein, D., & Miller, R. T. (2011). Slow off the Mark: Elementary School Teachers and the Crisis in Science, Technology, Engineering, and Math Education. *Center for American Progress.*

Eris, O., Chachra, D., Chen, H. L., Sheppard, S., Ludlow, L., Rosca, C., . . . Toye, G. (2010). Outcomes of a longitudinal administration of the persistence in engineering survey. *Journal of Engineering Education, 99*, 371-395. doi:10.1002/j.2168-9830.2010.tb01069.x

Espinosa, L. (2011). Pipelines and pathways: Women of color in undergraduate STEM majors and the college experiences that contribute to persistence. *Harvard Educational Review, 81*, 209-241.

Felder, R. M., & Brent, R. (2005). Understanding student differences. *Journal of Engineering Education, 94*, 57-72. doi:10.1002/j.2168-9830.2005.tb00829.x

Flowers, L. O. (2012). Various programs are in place to help minorities successfully pursue STEM graduate degrees. *Diverse Issues in Higher Education, 29*, 19.

Foor, C. E., Walden, S. E., & Trytten, D. A. (2007). "I wish that I belonged more in this whole engineering group": Achieving individual diversity. *Journal of Engineering Education, 96*, 103-115. doi:10.1002/j.2168-9830.2007.tb00921.x

French, B. F., Immekus, J. C., & Oakes, W. C. (2005). An examination of indicators of engineering students' success and persistence. *Journal of Engineering Education, 94*, 419-425. doi:10.1002/j.2168-9830.2005.tb00869.x

Fries-Britt, S. L., Younger, T. K., & Hall, W. D. (2010). Lessons from high-achieving students of color in physics. *New Directions for Institutional Research, 2010*(148), 75-83. doi:10.1002/ir.363

Froyd, J. E., & Ohland, M. W. (2005). Integrated engineering curricula. *Journal of Engineering Education, 94*, 147-164. doi:10.1002/j.2168-9830.2005.tb00835.x

Gibson, M. K., & Papa, M. J. (2000). The mud, the blood, and the beer guys: Organizational osmosis in blue-collar work groups. *Journal of Applied Communication Research, 28*, 68-88. doi:10.1080/00909880009365554

Grandy, J. (1998). Persistence in science of high-ability minority students: Results of a longitudinal study. *The Journal of Higher Education, 69*, 589-620. doi:10.2307/2649210

Griffin, K. A., Pérez, D., Holmes, A. P., & Mayo, C. E. (2010). Investing in the future: The importance of faculty mentoring in the development of students of color in STEM. *New Directions for Institutional Research, 2010*(148), 95-103. doi:10.1002/ir.365

Hagedorn, L. S. (2005). How to define retention: A new look at an old problem. In A. Seidman (Ed.), *College student retention: A formula for student success* (pp. 89-106). Westport, CT: Praeger Publishers.

Harper, S. R. (2006). Peer support for African American male college achievement: Beyond internalized racism and the burden of "acting white." *Journal of Men's Studies, 14*, 337-358. doi:10.3149/jms.1403.337

Harper, S. R. (2008). Realizing the intended outcomes of Brown: High-achieving African American male undergraduates and social capital. *American Behavioral Scientist, 51*, 1030-1053. doi:10.1177/0002764207312004

Harper, S. R. (2010). An anti-deficit achievement framework for research on students of color in STEM. *New Directions for Institutional Research, 2010*(148), 63-74. doi:10.1002/ir.362

Hartman, H. (2006). Leaving engineering: Lessons from Rowan University's college of engineering. *Journal of Engineering Education, 95*, 49-61. doi:10.1002/j.2168-9830.2006.tb00877.x

Hausmann, L. R. M., Schofield, J. W., & Woods, R. L. (2007). Sense of belonging as a predictor of intentions to persist among African American and white first-year college students. *Research in Higher Education, 48*, 803-839. doi:10.1007/s11162-007-9052-9

Heidel, J., Ali, H., Corbett, B., Liu, J., Morrison, B., O'Connor, M., . . . Ryan, C. (2011). Increasing the number of homegrown STEM majors: What works and what doesn't. *Science Educator, 20*, 49-54.

Hellman, C., & Harbeck, D. (1997). Academic self-efficacy: Highlighting the first-generation student. *Journal of Applied Research in the Community College, 4*, 165-169.

Hill, P. L., Shaw, R. A., Taylor, J. R., & Hallar, B. L. (2011). Advancing diversity in STEM. *Innovative Higher Education, 36*, 19-27. doi:10.1007/s10755-010-9154-8

Hong, B., & Shull, P. J. (2010). A retrospective study of the impact faculty dispositions have on undergraduate engineering students. *College Student Journal, 44*, 266-278.

Hurtado, S., & Carter, D. F. (1997). Effects of college transition and perceptions of the campus racial climate on Latino college students' sense of belonging. *Sociology of Education, 70*, 324-345. doi:10.2307/2673270

Hurtado, S., Cabrera, N. L., Lin, M. H., Arellano, L., & Espinosa, L. L. (2009). Diversifying science: Underrepresented student experiences in structured research programs. *Research in Higher Education, 50*, 189-214. doi:10.1007/s11162-008-9114-7

Hurtado, S., Newman, C. B., Tran, M. C., & Chang, M. J. (2010). Improving the rate of success for underrepresented racial minorities in STEM fields: Insights from a national project. *New Directions for Institutional Research, 2010*, 5-15. doi:10.1002/ir.357

Hutchison, M. A., Follman, D. K., Sumpter, M., & Bodner, G. M. (2006). Factors influencing the self-efficacy beliefs of first-year engineering students. *Journal of Engineering Education, 95*, 39-47. doi:10.1002/j.2168-9830.2006.tb00876.x

Hutchison-Green, M., Follman, D. K., & Bodner, G. M. (2008). Providing a voice: Qualitative investigation of the impact of a first-year engineering experience on students' efficacy beliefs. *Journal of Engineering Education, 97*, 177-190. doi:10.1002/j.2168-9830.2008.tb00966.x

Iverson, B. K., Pascarella, E. T., & Terenzini, P. T. (1984). Informal faculty-student contact and commuter college freshmen. *Research in Higher Education, 21*, 123-136. doi:10.1007/BF00975100

Jacobs, J. E. (2005). Twenty-five years of research on gender and ethnic differences in math and science career choices: What have we learned? *New Directions for Child and Adolescent Development, 2005*(110), 85-94. doi:10.1002/cd.151

Johnson, C. C. (2012). Implementation of STEM education policy: Challenges, progress, and lessons learned. *School Science and Mathematics, 112*, 45-55. doi:10.1111/j.1949-8594.2011.00110.x

Johnson, R. M. (2000). Investigating the process of persistence. In J. M. Braxton (Ed.), *Reworking the student departure puzzle* (1st ed., pp. 157-169). Nashville, TN: Vanderbilt University Press.

Kamens, D. H. (1981). Organizational and institutional socialization in education. In A. Kerckhoff, & R. Corwin (Eds.), *Research in sociology of education and socialization* (Volume 2 ed., pp. 111-126). Greenwich, CT: JAI Press.

Karen, D., & Dougherty, K. (2005). Necessary but not sufficient: Higher education as a strategy of social mobility. In G. Orfield, P. Marin, & C. L. Horn (Eds.), *Higher education and the color line: College access, racial equity, and social change* (pp. 33-58). Cambridge, MA: Harvard Education Press.

Karp, M. M. (2012). I don't know, I've never been to college!" dual enrollment as a college readiness strategy. *New Directions for Higher Education, 2012*(158), 21-28. doi:10.1002/he.20011

Keshishian, F. (2010). Factors influencing pharmacy students' choice of major and its relationship to anticipatory socialization. *American Journal of Pharmaceutical Education, 74*, 1-6. doi:10.5688/aj740475

Krauss, I. (1964). Sources of educational aspirations among working-class youth. *American Sociological Review, 29*, 867-879. doi:10.2307/2090871

Kuh, G. D., & Love, P. G. (2000). A cultural perspective on student departure. In J. Braxton (Ed.), *Reworking the student departure puzzle* (pp. 196-212). Nashville, TN: Vanderbilt University Press.

Laden, B. V., Milem, J. V., & Crowson, R. L. (2000). New institutional theory and student departure. In J. Braxton (Ed.), *Reworking the student departure puzzle*, (pp. 235-256). Nashville, TN: Vanderbilt University Press.

Li, Q., Swaminathan, H., & Tang, J. (2009). Development of a classification system for engineering student characteristics affecting college enrollment and retention. *Journal of Engineering Education, 98*, 361-376. doi:10.1002/j.2168-9830.2009.tb01033.x

Lichtenstein, G. (2010). Comparing the undergraduate experience of engineers to all other majors: Significant differences are programmatic. *Journal of Engineering Education, 99*, 305-317. doi:10.1002/j.2168-9830.2010.tb01065.x

Litzler, E., & Young, J. (2012). Understanding the risk of attrition in undergraduate engineering: Results from the project to assess climate in engineering. *Journal of Engineering Education, 101*, 319-345. doi:10.1002/j.2168-9830.2012.tb00052.x

Lord, S. M., Camacho, M. M., Layton, R. A., Long, R. A., Ohland, M. W., & Wasburn, M. H. (2009). Who's persisting in engineering? A comparative analysis of female and male Asian, Black, Hispanic, Native American, and White students. *Journal of Women and Minorities in Science and Engineering, 15*,167-190. doi:10.1615/JWomenMinorScienEng.v15.i2.40

Lowell, B. L., & Salzman, H. (2007). *Into the eye of the storm: Assessing the evidence on science and engineering education, quality, and workforce demand.* Retrieved from http://www.urban.org/UploadedPDF/411562_Salzman_Science.pdf

Lucas, K. (2011). Socializing messages in blue-collar families: Communicative pathways to social mobility and reproduction. *Western Journal of Communication, 75*, 95-121. doi:10.1080/10570314.2010.536964

Majors, R., & Billson, J. (1992). *Cool pose: The dilemmas of black manhood in America*. New York, New York: Lexington Books

Marra, R., Rodgers, K. A., Shen, D., & Bogue, B. (2009). Women engineering students and self-efficacy: A multi-year, multi-institution study of women engineering student self- efficacy. *Journal of Engineering Education, 98*, 27-38.

Marra, R. M., Rodgers, K. A., Shen, D., & Bogue, B. (2012). Leaving engineering: A multi-year single institution study. *Journal of Engineering Education, 101*, 6-27. doi:10.1002/j.2168-9830.2009.tb01003.x

Matusovich, H. M., Streveler, R. A., & Miller, R. L. (2010). Why do students choose engineering? A qualitative, longitudinal investigation of students' motivational values. *Journal of Engineering Education, 99*, 289-303. doi:10.1002/j.2168-9830.2010.tb01064.x

Mauss, A. L. (1969). Anticipatory socialization toward college as a factor in adolescent marijuana use. *Social Problems, 16*, 357-364. doi:10.2307/799669

McGee, E. O., & Martin, D. B. (2011). "You would not believe what I have to go through to prove my intellectual value!" stereotype management among academically successful black mathematics and engineering students. *American Educational Research Journal, 48*, 1347-1389. doi:10.3102/0002831211423972

McKeganey, N. (2001). To pay or not to pay: respondents' motivation for participating in research. *Addiction, 96*, 1237-1238. doi:10.1046/j.1360-0443.2001.96912371.x

Merriam, S. B. (1998). *Qualitative research and case study applications in education* (2nd. ed.). San Francisco, CA: Jossey-Bass.

Merton, R. K. (1968). *Social theory and social structure* (2nd ed.). New York, NY: Free Press.

Merton, R. K. (1972). Insiders and outsiders: A chapter in the sociology of knowledge. *American Journal of Sociology*, 9-47.

Moore, J. L., Madison-Colmore, O., & Smith, D. M. (2003). The prove-them-wrong syndrome: Voices from unheard African-American males in engineering disciplines. *The Journal of Men's Studies, 12*, 61-73. doi:10.3149/jms.1201.61

Mortenson, T. G. (2005). Measurements of persistence. In A. Seidman (Ed.), *College student retention: Formula for student success* (pp. 31-61). Westport, CT: Praeger Publishers.

Museus, S. D., Harper, S. R., & Nichols, A. H. (2010). Racial differences in the formation of postsecondary educational expectations: A structural model. *Teachers College Record, 112*, 811-842.

National Academy of Sciences. (2007). *Rising above the gathering storm* (Revised ed.). Washington, D.C.: National Academies Press.

National Academy of Sciences. (2010). *Rising above the gathering storm revisited: Rapidly approaching category 5.* Washington, D.C.: National Academies Press.

National Action Council for Minorities in Engineering (2011). *African Americans in engineering.* White Plains, NY: Frehill.

National Center for Education Statistics. (2013). *Higher education: Gaps in access and persistence study.* Retrieved from http://nces.ed.gov/pubs2012/2012046/tables/e-42-2.asp

National Defense Education Program. (2014). Faq's. Retrieved from http://www.ndep.us/FAQs.aspx

National Research Council of the National Academies. (2005). *Bridges to independence: Fostering the independence of new investigators in biomedical research.* Washington, D.C.: National Academies Press.

National Research Council. (2011). *Successful K-12 stem education: Identifying effective approaches in science, technology, engineering, and mathematics*. Washington, DC: The National Academies Press.

National Science Foundation, Division of Science Resources Statistics. (2010). *Science and Engineering Degrees, by Race/Ethnicity of Recipients: 1997–2006.* Detailed Statistical Tables NSF 10-300. Arlington, VA. Retrieved from http://www.nsf.gov/statistics/nsf10300/

Nora, A., Barlow, E., & Crisp, G. (2005). Student persistence and degree attainment beyond the first year in college: The need for research. In A. Seidman (Ed.), *College student retention: Formula for student success* (pp. 129-154). Westport, CT: Praeger Publishers.

Ohland, M. W., Brawner, C. E., Camacho, M. M., Layton, R. A., Long, R. A., Lord, S. M., & Wasburn, M. H. (2011). Race, gender, and measures of success in engineering education. *Journal of Engineering Education, 100*, 225-252. doi:10.1002/j.2168-9830.2011.tb00012.x

Ohland, M. W., Sheppard, S. D., Lichtenstein, G., Eris, O., Chachra, D., & Layton, R. A. (2008). Persistence, engagement, and migration in engineering programs. *Journal of Engineering Education, 97*, 259-278. doi:10.1002/j.2168-9830.2008.tb00978.x

Ohland, M. W., Yuhasz, A. G., & Sill, B. L. (2004). Identifying and removing a calculus prerequisite as a bottleneck in Clemson's general engineering curriculum. *Journal of Engineering Education, 93*, 253-257. doi:10.1002/j.2168-9830.2004.tb00812.x

Palmer, R. T., Maramba, D. C., & Dancy, T. E. (2011). A qualitative investigation of factors promoting the retention and persistence of students of color in STEM. *The Journal of Negro Education, 80*, 491-504.

Pascarella, E. T., & Chapman, D. W. (1983). A multi-institutional, path analytic validation of Tinto's model of college withdrawal. *American Educational Research Journal, 20*, 87-102.

Perna, L. W., & Thomas, S. L. (2008). In K. Ward, & L. Wolf-Wendel (Eds.), *Theoretical perspectives on student success: Understanding the contributions of the disciplines*. San Francisco, CA: Jossey-Bass. doi:10.1002/aehe.3401

Perna, L. W., Gasman, M., Gary, S., Lundy-Wagner, V., & Drezner, N. D. (2010). Identifying strategies for increasing degree attainment in STEM: Lessons from minority-serving institutions. *New Directions for Institutional Research, 2010*(148), 41-51. doi:10.1002/ir.360

Price, J. (2010). The effect of instructor race and gender on student persistence in STEM fields. *Economics of Education Review, 29*, 901-910. doi:10.1016/j.econedurev.2010.07.009

Rask, K. (2010). Attrition in STEM fields at a liberal arts college: The importance of grades and pre-collegiate preferences. *Economics of Education Review, 29*, 892-900. doi:10.1016/j.econedurev.2010.06.013

Rendon, L. I., Jalomo, R. E., & Nora, A. (2000). Theoretical considerations in the study of minority student retention in higher education. In J. M. Braxton (Ed.), *Reworking the student departure puzzle* (pp. 127-156). Nashville, TN: Vanderbilt University Press.

Riley, S. (2013, June 14). Proposed U.S. budget eyes manufacturing innovation; STEM education also a focus; allocates $ 2.9 billion for advanced manufacturing R & D, up to 15 institutes. *Investor's Business Daily*, pp. A04.

Rothwell, J. T., & Ruiz, N. G. (2013). *H-1B visas and the STEM shortage: A research brief.* Washington, D.C.: Social Science Research Network. doi:http://dx.doi.org/10.2139/ssrn.2262872

Rutherford, F. J. (1998). *Sputnik and science education*. Retrieved from http://www.nas.edu/sputnik/ruther1.htm

Saenz, T., Marcoulides, G. A., Junn, E., & Young, R. (1999). The relationship between college experience and academic performance among minority students. *International Journal of Educational Management, 13*, 199-207. doi:10.1108/09513549910278124

Scott, C. (2012). An Investigation of Science, Technology, Engineering and Mathematics (STEM) Focused High Schools in the US. *Journal of STEM Education: Innovations and Research, 13*, 30-39.

Seymour, E. (1999). The role of socialization in shaping the career-related choices of undergraduate women in science, mathematics, and engineering majors. *Annals of the New York Academy of Sciences, 869*, 118-126. doi:10.1111/j.1749-6632.1999.tb08366.x

Seymour, E., & Hewitt, N. M. (1997). *Talking about leaving: Why undergraduates leave the sciences*. Boulder, CO: Westview Press.

Shields, N. (2002). Anticipatory socialization, adjustment to university life, and perceived stress: Generational and sibling effects. *Social Psychology of Education, 5*, 365-392.

Simpson, R. L. (1962). Parental influence, anticipatory socialization, and social mobility. *American Sociological Review, 27*, 517-522. doi:10.2307/2090033

Singleton, R A.., & Straits, B. C. (2012). Survey Interviewing. In J.F. Gubrium, J.A. Holstein, A.B. Marvasti, & K. D. McKinney (Eds.), *The Sage handbook of interview research: The complexity of the craft* (pp. 77-98). Thousand Oaks, CA: Sage Publications, Inc.

Spady, W. G. (1970). Dropouts from higher education: An interdisciplinary review and synthesis. *Interchange, 1*, 64-85. doi:10.1007/BF02214313

Spradley, J. P. (1979). *The ethnographic interview*. Belmont, CA: Wadsworth Group/Thompson Learning.

Stake, R. E. (2005). Qualitative case studies. In N. K. Denzin, & Y. S. Lincoln (Eds.), *The sage handbook of qualitative research* (3rd ed., pp. 443-466). Thousand Oaks, CA: Sage Publications.

Stake, R. E. (2006). *Multiple case study analysis*. New York, NY: The Guilford Press.

Subotnik, R. F., Tai, R. H., Rickoff, R., & Almarode, J. (2010). Specialized public high schools of science, mathematics, and technology and the STEM pipeline: What do we know now and what will we know in 5 years? *Roeper Review, 32*, 7-16. doi:10.1080/02783190903386553

Symonds, W. C., Schwartz, R. B., & Ferguson, R. (2011). *Pathways to prosperity: Meeting the challenge of preparing young Americans for the 21st century.* Boston, MA: Pathways to Prosperity Project, Harvard Graduate School of Education.

Thornton, R., & Nardi, P. M. (1975). The dynamics of role acquisition. *American Journal of Sociology, 80*, 870-885. doi:10.1086/225897

Tierney, W. G. (2000). Power, identity, and the dilemma of college student departure. In J. Braxton (Ed.), *Reworking the student departure puzzle* (pp. 213-234). Nashville, TN: Vanderbilt University Press.

Tinto, V., & Pusser, B. (2006). *Moving from theory to action: Building a model of institutional action for student success.* Washington, D.C.: National Postsecondary Education Cooperative.

Tinto, V. (1993). *Leaving college : Rethinking the causes and cures of student attrition* (2nd ed.). Chicago, IL: University of Chicago Press. doi:10.7208/chicago/9780226922461.001.0001

Tyson, W. (2011). Modeling engineering degree attainment using high school and college physics and calculus coursetaking and achievement. *Journal of Engineering Education, 100*, 760-777. doi:10.1002/j.2168-9830.2011.tb00035.x

United States Census Bureau. (2012). *Age and sex composition in the United States: 2011.* Retrieved from http://www.census.gov/population/age/data/2011comp.html

University of Maryland Baltimore County. (2013a). *Meyerhoff scholars program:13 key components*. Retrieved from http://umbc.edu/meyerhoff/program_key_components.html

University of Maryland Baltimore County. (2013b). *Program results.* Retrieved from http://umbc.edu/meyerhoff/program_results.html

Veenstra, C. P., Dey, E. L., & Herrin, G. D. (2009). A model for freshman engineering retention. *Advances in Engineering Education, 1*, 1-31.

Venkatesh, S. (2002). Doin' 'the hustle' Constructing the ethnographer in the American ghetto. Ethnography, 3, 91-111. doi:10.1177/1466138102003001004

Villapando, O., & Solorzano, D. G. (2005). The role of culture in college preparation programs: A review of the research literature. In W. Tierney, Z. Corwin, & J. Colyar (Eds.), *Preparing for college: Nine elements of effective outreach* (pp. 13-28). Albany, NY: SUNY Press.

Virginia Higher Education Act, Gen. Assemb. H2510, 828 (Vir. Stat. 2011)

Virginia Tech (2013). *College of engineering | Virginia Tech.* Retrieved from http://www.admiss.vt.edu/majors/index.php/majors/college/coe

Vogt, C. M. (2008). Faculty as a critical juncture in student retention and performance in engineering programs. *Journal of Engineering Education, 97*, 27-36.

Walden, S. E., & Foor, C. (2008). "What's to keep you from dropping out?" student immigration into and within engineering. *Journal of Engineering Education, 97*, 191-205. doi:10.1002/j.2168-9830.2008.tb00951.x

Weidman, J. C. (1989). The world of higher education: A socialization-theoretical perspective. In K. Hurrelmann, & U. Engel (Eds.), *The social world of adolescents* (pp. 87-106). Berlin, Germany: Walter de Gruyter.

Weidman, J. C., Twale, D. J., & Stein, E. L. (2001). *Socialization of graduate and professional students in higher education: A perilous passage? ASHE-ERIC higher education report, volume 28, number 3. Jossey-Bass higher and adult education series.* San Francisco, CA: Jossey-Bass.

Whitla, D. K., Howard, C., Tuitt, F., Reddick, R. J., & Flanagan, E. (2005). Diversity on campus: Exemplary programs for retaining and supporting students of color. In G. Orfield, P. Marin, & C. Horn (Eds.), *Higher education and the color line: College access, racial equity, and social change* (pp. 131-151). Cambridge, MA: Harvard Education Press.

Wilson, A. B. (1959). Residential segregation of social classes and aspirations of high school boys. *American Sociological Review, 24*, 836-845. doi:10.2307/2088572

Wilson, Z., Iyengar, S., Pang, S., Warner, I., & Luces, C. (2012). Increasing access for economically disadvantaged students: The NSF/CSEM & S-STEM programs at Louisiana State University. *Journal of Science Education and Technology, 21*, 581-587. doi:10.1007/s10956-011-9348-6

Wood, J. L. (2011). Falling through the cracks. *Diverse: Issues in Higher Education, 28*(18), 24-24.

Wood, J. L. (2012). Leaving the 2-year college: Predictors of black male collegian departure. *Journal of Black Studies, 43*, 303-326. doi:10.1177/0021934711424490

World Health Organization. *WHO informed consent form templates.* Retrieved from http://www.who.int/rpc/research_ethics/informed_consent/en/

Yin, R. K. (2003). *Applications of case study research* (2nd ed.). Thousand Oaks, CA: Sage Publications.

Yin, R. K. (2009). *Case study research: Design and methods* (4th ed.). Los Angeles, CA: Sage.

Young, A. A. (2014). Experiences in ethnographic interviewing about race: The inside and outside of it (pp. 187-202). In M. Blumer & J. Solomos (Eds.), *Researching race and racism.* New York, New York: Routledge.

Zhang, G., Anderson, T. J., Ohland, M. W., & Thorndyke, B. R. (2004). Identifying factors influencing engineering student graduation: A longitudinal and cross-institutional study. *Journal of Engineering Education, 93*, 313-320. doi:10.1002/j.2168-9830.2004.tb00820.x

Zurita, M. (2004). Stopping out and persisting: Experiences of Latino undergraduates. *Journal of College Student Retention Research Theory and Practice, 6*, 301-324. doi:10.2190/T3QL-V9RD-CMVB-6XQX

Appendix A

Interview Protocol

| Anticipatory Socialization Source | Attrition contributing factor | Question Type | Question Text |
|---|---|---|---|
| N/A | N/A | Structural | Describe the process through which you decided to major in engineering in college. |
| N/A | N/A | Descriptive | Why did you decide to major in engineering in college? |
| Parents | Career value congruency | Descriptive | Have you ever talked to your parents/guardians about careers? If so, what types of careers did you talk about? |
| Siblings | Career value congruency | Descriptive | Have you ever talked to your siblings about careers? If so, what types of careers did you talk about? |
| Peers | Career value congruency | Descriptive | Have you ever talked to your high school friends about careers? If so, what types of careers did you talk about? |
| Secondary Education | Career value congruency | Descriptive | Have you ever talked to your high school and middle school teachers about careers? If so, what types of careers did you talk about? |
| N/A | Career value congruency | Descriptive | Were there any other people that may have influenced your choice of career? |
| N/A | Career value congruency/ Context | Descriptive | What did you learn, if anything, about careers during your first two years of college? |
| N/A | Career value congruency | Contrast | What do you know now about careers that you wish you had known in high school? |
| N/A | Career value congruency | Contrast | How did the advice you received about careers differ between your friends in high school, your family, and your teachers in high school? |
| N/A | Career value congruency | Descriptive | Do you think your community encourages pursuing certain careers? If so, what careers do you think are particularly valued by your community? |

| | | | |
|---|---|---|---|
| N/A | Participation in collegiate peer groups | Descriptive | Do you belong to any campus extra-curricular organizations? If so, which ones do you belong to? |
| N/A | Participation in collegiate peer groups | Structural | How did you decide to join or not to join campus organizations? |
| N/A | Participation in collegiate peer groups/Context | Descriptive | Do you think that your college encourages participation in extra-curricular activities? If so, what types of extra-curricular activities does the college encourage? |
| Parents | Participation in collegiate peer groups | Descriptive | Did you ever talk to your parents about the social aspects of college? If so, what types of activities did you talk about? |
| Siblings | Participation in collegiate peer groups | Descriptive | Did you ever talk to your siblings about the social aspects of college? If so, what types of activities did you talk about? |
| Peers | Participation in collegiate peer groups | Descriptive | Did you ever talk to your high school friends about the social aspects of college? If so, what types of activities did you talk about? |
| Secondary Education | Participation in collegiate peer groups | Descriptive | Did you ever talk to your teachers in high school or middle school about the social aspects of college? If so, what types of activities did you talk about? |
| N/A | Participation in collegiate peer groups | Descriptive | If you were a member of college organizations, how did your membership in these organizations affect your decisions regarding college enrollment? |
| N/A | Participation in collegiate peer groups | Descriptive | If you were a member of college organizations, how did your membership in these organizations affect your academic work? |
| N/A | Participation in collegiate peer groups | Contrast | What is different about the peer groups in college versus those in high school? |
| N/A | Independence versus help-seeking behavior | Descriptive | Did you get help with your studies in high school? |

| | | | |
|---|---|---|---|
| N/A | Independence versus help-seeking behavior | Descriptive | Have you received help with your studies in college? What type of help? Why or why not? Did you seek help with your studies? |
| N/A | Independence versus help-seeking behavior | Contrast | How would you describe the differences between your experience seeking help in high school and seeking help in college? |
| N/A | Independence versus help seeking behavior | Structural | How did you decide to ask for or not ask for help with your studies in college? |
| Parents | Independence versus help-seeking behavior | Descriptive | Did you ever talk to your parents/guardians about how to get academic support in college? If so, what types of support did you talk about? Were these discussions useful? Have you used the advice given to you in these discussions? Why or why not? |
| Siblings | Independence versus help-seeking behavior | Descriptive | Did you ever talk to your siblings about how to get academic support in college? If so, what types of support did you talk about? Were these discussions useful? Have you used the advice given to you in these discussions? Why or why not? |
| Peers | Independence versus help-seeking behavior | Descriptive | Did you ever talk to your high school friends about how to get academic support in college? If so, what types of support did you talk about? Were these discussions useful? Have you used the advice given to you in these discussions? Why or why not? |
| Secondary Education | Independence versus help-seeking behavior | Descriptive | Did you ever talk to your middle school or high school teachers about how to get academic support in college? If so, what types of support did you talk about? Were these discussions useful? Have you used the advice given to you in these discussions? Why or why not? |
| N/A | Independence versus help-seeking behavior | Descriptive | What factors encouraged or discouraged you from seeking academic help during college? |

| | | | |
|---|---|---|---|
| N/A | N/A | Descriptive | Describe the factors that contributed your decision to continue/stop majoring in engineering in college. |

## Appendix B

### Participant Release Form

Dear Participant:

You have been invited to take part in this research, because as an African American male engineering or ex-engineering student, you have unique and valuable insight regarding your experience in an engineering program. Only students who have experienced the engineering program can provide information about what it is like in the program, and what influenced their decision to stay or leave the engineering program. I am providing this information to you for you to be able to decide whether or not you want to participate in this research.

Your participation in this research is entirely voluntary. Other than the researcher, no one will know if you choose not to participate in this research. Not participating in the research will have no effect on your grades or your standing in the university. You may change your mind about participating at any time and stop participating even if you agreed to participate earlier.

The purpose of this study is to determine reasons for male African American engineering student attrition. While researchers know some of the reasons why students leave engineering programs, little research has been done regarding African American students in engineering programs. In addition, little research has been performed by talking to students in engineering programs to determine the reasons that students leave these programs. I want to learn about why students leave engineering programs to improve the quality of engineering programs and improve the quality of preparation that students receive before they enter engineering programs. I hope that by learning about the experiences that engineering and former engineering students had in high school I will be able to learn why some students stay in engineering programs and why some students leave.

The research will take place during three sessions. The first two sessions will be interviews, and last approximately two hours. During the third session, I will review my findings with you to ensure that you understand and agree with my interpretations of the findings. The third session will take approximately one hour.

I will begin by asking some questions about your background and your decision to either stay or leave engineering studies. I will also ask for your college transcript, your high school transcript, and your SAT scores. I will ask about how you were prepared by your family, friends, and high school for college. A typical question that I might ask would be:

What careers do you feel have value to the community? Why do you feel that these careers have value?

The interview will take place at a location of your choice. I will be the only person who takes part in this conversation with you. The entire conversation will be stored digitally on an MP3 recorder. The MP3 recorder will be either kept on my person at all times or stored in a secure area of my office. I will have the MP3 recordings transcribed by AudioTranscription.org after

removing any identifying information from the MP3. The MP3 recordings will be erased after completion of my doctoral study, which is anticipated to be in September of 2014.

It is unlikely that there will be any risks to you from participation in this study. If at any time you do not feel comfortable answering a question, you may stop the interview process, or choose to not answer that question. There is likely to be no personal benefit to you as a result of your participation in this research. However, the results from this research may be used to improve the experience of future college and high school students.

You will be reimbursed a total of $60 for your participation in this research. We anticipate that you will participate for approximately five hours during the course of this research, so your reimbursement will be approximately $12 per hour of participation.

I will not reveal any personally identifiable information you provide during the course of this study to anyone. Your name will be replaced by another means of identification on all physical and electronic documentation collected as part of this project. The names of your college and high school will be changed in all documentation as well. Your words may be used as part of a publication; however, your name will not be associated in any way with any publication.

If you have any questions, you can ask them at any time. If you have questions, you may call me at:

Jake Joseph (804)310-5677

Or email me at jdjoseph@wm.edu or jakejoseph@gmail.com

This proposal has been reviewed and approved by the EDRIC IRB at The College of William and Mary. The EDRIC IRB is a committee whose task it is to make sure that research participants are protected from harm. If you wish to find about more about the IRB, contact Dr. Tom Ward at (757)221-2358. The Applicable IRB Number is:
EDIRC - 2013 - 08 -14- 8874-jdjoseph

Your signature below indicates that you have full knowledge of the nature and purpose of the procedures. You will be given a copy of the consent form to keep.

Print Name of Participant_____

Signature of Participant _____

Date _____
Day/month/year

# Appendix C

*Table C1*: Student Demographic Information

| Chosen Pseudonym | Colleges Attended | Current Level | SAT | H.S. GPA | College GPA | Current Major | Former Major | Career Goal | Parent/Guardian 1 Occupation | Parent/Guardian 2 Occupation |
|---|---|---|---|---|---|---|---|---|---|---|
| John[a] | HCU | Junior | DNA | DNA | DNA | Mechanical Engineering | | DNA | DNA | DNA |
| James Franco | HCU | Sophomore | 1950 | 4.2 | 3.93 | Mechanical Engineering | | PhD in mechanical engineering | Government contractor | Entrepreneur/ restaurant owner. |
| Juan | CSU | Freshman | 1890 | 3.5 | 3 | Mechanical Engineering | | Government Employee | Government employee | Government employee |
| Deton | Community College, CSU | Senior | 1760 | DNA | 2.2 | Chemical and Life Science Engineering | | Increase amount of freshwater world wide by 1- 3%. Investigate the field of nanotechnology , especially to see if I can mimic the creation of silk, particularly spider silk. Own my own defense contracting firm or something similar to Lockheed Martin. | DOD commissary agent | Substitute teacher |

| Chosen Pseudonym | Colleges Attended | Current Level | SAT | H.S. GPA | College GPA | Current Major | Former Major | Career Goal | Parent/Guardian 1 Occupation | Parent/Guardian 2 Occupation |
|---|---|---|---|---|---|---|---|---|---|---|
| Lupe | HCU | Junior | 1770 | 3.86 | 3.28 | Computer Engineering | | Masters in computer engineering working for a tech firm or government | Mother - pharmacist | Father - independent businessman |
| Bob | HCU | Junior | 1730 | 4.09 | 3.38 | Mechanical Engineering and Music Minor | | Automotive engineer | Community planning and cyber security policy | Staff minister |
| Cyrus | HCU | Junior | 1860 | 3.35 | 3.2 | Accounting and Information Systems | Mechanical Engineering | Accounting liaison between the US and Germany | Pharmacist | |
| Ian[a] | HCU | Junior | 1700 | 3.4 | 3.147 | Mechanical Engineering | | To own my own engineering firm that produces medical devices | Government agency accountant | Government agency manager |
| Alex Smith | HCU | Super Senior | 1850 | 3.65 | 3.1 | Mechanical Engineering | | PhD | State architect | I don't know |
| Aaron[a] | HCU | Graduate | DNA | DNA | DNA | Graphic Design | Mechanical Engineering | DNA | DNA | DNA |
| David | CSU | Senior | 1540 | 3.79 | 2.71 | Chemical Engineering | | Government, Industrial, Graduate School, Running own business | Government contractor work | Owner, founder and CEO of non-profit |
| Abraham | CSU | DNA | DNA | DNA | DNA | Mechanical Engineering | Computer Science | DNA | DNA | DNA |
| AW | Community College, CSU | Senior | No SAT | 3.5 | 2.9 | Computer Engineering | Business Administration | Software engineer or cyber security analyst | Doctor's secretary | Mail clerk |
| Jerry[be] | HBCU /CSU | Junior | 1260 | 2.6 | 3 | Computer[c] Science | | Start a company | Social Worker | DNA |

| Chosen Pseudonym | Colleges Attended | Current Level | SAT | H.S. GPA | College GPA | Current Major | Former Major | Career Goal | Parent/Guardian 1 Occupation | Parent/Guardian 2 Occupation |
|---|---|---|---|---|---|---|---|---|---|---|
| Thomas[a] | CSU | Sophomore | DNA | 3.4 | 3.4 | Mechanical Engineering | | DNA | Engineering technical | Administrator for social services |
| Louis[b] | HCU | DNA | DNA | DNA | DNA | Information Systems | Engineering | DNA | DNA | DNA |
| Timothy James | HCU | Super Senior[d] | 1700 | 2.75 | 2.5 | Financial Economics | Mechanical Engineering | Auditor | Law enforcement | Executive assistant |
| Slim | Community College, HCU | Senior | 1700 | 3.2 | 3.3 | Health Administration and Policy | Mechanical Engineering and Biology | Pharmacist | Social worker | Federal employee |
| Brandon[b] | HCU | DNA | DNA | DNA | DNA | Engineering | DNA | DNA | DNA | DNA |
| Ralph Lauren | CSU | Senior | 1100 | 3.5 | 3.1 | Exercise Science | Mechanical Engineering | Athletic trainer for major sports team | Elementary school Bookkeeper | Custodian |
| Daniel | Community College, CSU | Junior | NA | 3.7 | 3.2 | Mechanical Engineering with Nuclear Option | General Studies | Possibly work for NASA and look into the feasibility of nuclear propulsion for spacecraft...or get involved in medicinal purposes of nuclear energy | Army | DNA |

*Notes:*

DNA – Did not answer question.

With the exception of John, Abraham, Louis, and Brandon, the responses are in the participants own words, and unedited. John, Abraham, Louis, and Brandon did not complete information sheets detailing this requested information.

a – Participant did not respond to request for pseudonym. I assigned a pseudonym, and emailed participant to determine suitability. Participant did not respond to request.

b - Participant did not respond to request for pseudonym. I assigned a pseudonym, and emailed participant to determine suitability. Participant agreed to suitability of pseudonym.

c – Included as engineering student because the computer science department is considered part of the engineering department at CSU.

d – Participants at HCU used the term Super Senior to indicate time to complete degree extended beyond four years.

e – Participant attended an HBCU before transferring to CSU