A STUDY OF ENGINEERING STUDENT ATTRIBUTES AND TIME TO COMPLETION OF FIRST YEAR REQUIRED COURSES AT TEXAS A&M UNIVERSITY

A Dissertation

by

JORJA LAY KIMBALL

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

May 2006

Major Subject: Educational Administration

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Approved by:

Chair of Committee,	Bryan Cole
Committee Members,	Cesar Malave
	Christine Stanley
	Karan Watson
Head of Department,	Jim Scheurich

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ABSTRACT

A Study of Engineering Student Attributes and Time to Completion of First Year Required Courses at Texas A&M University. (May 2006)

Jorja Lay Kimball, B.B.A., Texas A&I University;

M.B.A., Texas A&I University

Chair of Advisory Committee: Dr. Bryan Cole

For many years, colleges of engineering across the nation have required that a foundational set of courses be completed for entry into upper division coursework or into a specific engineering major. Since 1998, The Dwight Look College of Engineering at Texas A&M University (TAMU) has required that incoming first-time enrolling students complete a Core Body of Knowledge (CBK) with specific cumulative grade points required for specific majors. However, considerations of the time to completion of coursework and other student characteristics and academic factors have not been taken into consideration by TAMU, like most institutions. The purpose of this study is to determine for first year engineering students at TAMU the relationship of gender, ethnicity, engineering major, unmet financial need, cumulative grade point average, and total transfer hours on time to completion of CBK courses.

The results of the analysis showed that cumulative grade point average (CGPA) had the strongest relationship to completion of CBK of any independent variable in this study. Statistical significance was found for the following variables in this study: CGPA, gender, ethnicity, and unmet financial need. For the study's variable of major,

statistical significance was found for Chemical, Electrical, and Computer Engineering majors. The one variable in this study that did not show statistical significance in relation to time to completion of CBK was transfer credit. Findings with implications for recruitment and retention of underrepresented in engineering is a statistical significance indicating that on average females are taking less time than males to complete CBK.

The conclusion from the study is that efforts to attract more women into engineering have merit as do programs to support underrepresented students in order that they may complete CBK at a faster pace. Further study to determine profiles of those majors where statistical significance was found for students taking a greater or lesser amount of time for CBK completion than the mean is recommended, as is ongoing data collection and comparison for current cohorts of engineering majors at TAMU.

DEDICATION

This dissertation is dedicated to those who are my roots and future. I hope to always remember where I came from and those who helped me get this far in life, especially my wonderful husband Kenny and my parents, Vernon I. and Victoria Robles Lay, and to my two children Thomas Ethan and Katherine Victoria Kimball, who are the future of my world.

Jeremiah 29: 11-13

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A huge note of appreciation goes to Margaret Hobson for her encouragement and help with the statistics for this study. Margie, I would never have managed these stats without you! A big note of thanks to you and others in the office who persevered with me through this: Lauire, Olga, Julie, and Karen. Appreciation is also due to Dr. Jo Howze, Dr. Rita Caso, Marsha Lee, and Dr. Larry Malota for their assistance with obtaining data, and to Registrar, Don Carter for his help. A great debt of gratitude is owed to my boss, Dr. Theresa Maldonado, for her true and continuous support of me in achieving this goal. I shall toast you with vino, mi amiga!

To my parents, and my grandmothers, one who managed as a single mother and the one who never spoke English. Your support has brought me far. Mom, you and the girls will have to sit through the long ceremony and Dad will have to watch from a loftier perch. Family members are deeply appreciated for suffering along with me on

this for so long including all the Kimball clan and my sisters, Pat, Panna, Tot, and Rayni. Spiritual family are also owed a big thank you for all your prayers, particularly Vicki D. Sharon W., Heather F, Anna K, the Westfalls, the Sells, and the Wednesday/Thursday small group. Each of you is very special in my life whether I am Dr. Jorja or not.

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Last but most importantly, my love and heartfelt thanks go to Kenny, Katherine, and Ethan Kimball. You have your wife and mom back now!

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CHAPTER I

INTRODUCTION

Colleges of Engineering have long faced a problem of losing a significant number of students in the initial two years of an undergraduate degree program, with administrators and faculty also expressing concern over retention efforts while maintaining the quality of engineering education programs (Committee on Equal Opportunities in Science and Engineering, 1998; Felder, Woods, Stice, & Rugarcia, 2000c; Harris, DeLoatch, Grogan, Peden, & Winnery, 1994; Jackson, Gardner, & Sullivan, 1993; National Research Council, 1986). In most instances, quality programs have focused on high grade point averages and academic performance in particular courses designated as critical building blocks to upper level engineering curriculum, namely mathematics, chemistry and physics (National Academy of Engineering, 2004; National Research Council Center for Science, 1985; National Science Board, 1986; National Science Foundation, 1996; Pndergrass et al., 2001; Seely, 1999; Tobias, 1992). However, considerations of the time to completion of coursework and other student characteristics and academic factors have not been taken into consideration by most institutions. This present study will seek to find if time to completion of such foundational coursework at a major research institution has a relationship to student matriculation to upper level coursework in an engineering degree plan.

The style and format for this dissertation follow the *Journal of Educational Research*.

For more than twenty years, corporate America has been stating the need for more engineering graduates to keep the United States economically competitive (Choy, 2002; McGraw, 1999; National Research Council, 1986; National Research Council Center for Science, 1985; National Research Council, 2003; National Science Foundation, 1989). "If America is to achieve sustained economic growth and improved living standards in the next century, the creation and effective use of science and technology will be essential" (National Research Council, 1999). Problems associated with economic competitiveness were linked to student performance in mathematics, science, and engineering at both the K-12 and higher education levels (Bloom, 1987; National Research Council Center for Science, 1985; National Research Council, 1986; National Science Board, 1986; National Science Foundation, 1989) In response, a primary goal of engineering educators for the past two decades has been to increase the enrollment and graduation rates of students in engineering fields (American Society for Engineering Education, 1987; Bjorklund & Colbeck, 2001; Gardner & Broadus, 1990; National Science Board, 1986; National Science Foundation, 1996; Seymour, 2001). The two primary methods for increasing the number of engineering graduates, and thus providing the technical workforce needed to sustain and improve the U.S. economic performance, are to first recruit more students into engineering and then to improve the retention of these students.

The 1980's heralded an increasing concern regarding the state of undergraduate science, mathematics and engineering education in the United States. Particular attention was given to the recruitment and retention of women and minorities into science and engineering majors. Hispanics and African Americans were a growing pool from which to draw those individuals significantly underrepresented in the engineering profession (American Society for Engineering Education, 1987; National Research Council Center for Science, 1985; National Science Board, 2003). The focus in the 1990's was on the need for a highly technical workforce. Data gathered at that time predicted deficits in the number of highly-skilled technical workers needed versus those available in the engineering and technology fields (Campbell, 1997; Committee on Equal Opportunities in Science and Engineering, 1998; Georges, 1999; McGraw, 1999; Moller-Wong & Eide, 1997; National Research Council, 2003; Seymour, 2001).

Projections were that by 2005 almost 28 percent of the U.S. workforce will be comprised of minorities (Carnevale & Fry, 2000). Recently the Bureau of Labor Statistics (2004) projected that by 2012 the number of women in the labor force will grow faster than men, over 14% compared to men's' 10%. Whites will remain the largest group in the labor force, with Hispanics projected to account for the largest increase in the labor force estimated at 15% with African Americans at 12.2 % (Bureau of Labor Statistics, 2004). In the State of Texas, the Hispanic population is growing at an ever-increasing rate with projections of 250% growth in the population from 1990 to 2030 (Murdock, 1996). Predictions indicate that by 2030 the Anglo workforce in Texas will decrease significantly, with a substantial increase in the state's Hispanic workforce population during the same period (Alford, 1999; Murdock et al., 2002). Women and underrepresented minorities are predicted to become an increasing resource from which both higher education and industry must draw students and employees in Texas (American Council on Education, 2003; Carnevale & Fry, 2000; Murdock et al., 2002).

Shifts in demographics are occurring nationally among college age students. A recent study by the Educational Testing Service (Barton, 2003) projects that over the next two decades the number of undergraduates will grow by 19 percent, with substantial increases in incoming students by 2015 being minority – African American, Hispanic, and Pacific Islander. Texas will be heavily impacted with campus populations for the state anticipated to be 50 percent minority by 2015 (Carnevale & Fry, 2000).

While demographics are changing in the national population with minorities as an increasing portion, university enrollment in the fields of science and engineering do not reflect such increases in the African American or Hispanic populations. In fact, fewer high school graduates overall are choosing to enter the fields of science and engineering. In the mid 1980's more than eight percent of Bachelor of Science degrees were engineering majors. This figure drops to just over five percent nationally by 1996-1997. It is difficult to determine if industry needs will be met in a more robust economy (National Academy of Engineering, 2004; National Science Board, 2004; National Science Foundation, 1998). Undergraduate enrollment in engineering has declined approximately 19 percent from 1983 to 1996 (National Science Foundation, 1999a), and enrollment of women has remained stagnant other than in the field of computer science (National Science Board, 2004; National Science Foundation, 1999a, 2000).

If growth in the engineering workforce is to be nurtured in order to maintain economic competitiveness, it will be necessary to continue to focus on the recruitment and retention of women and underrepresented students (Barton, 2003; Committee on Equal Opportunities in Science and Engineering, 1998). Enrollment of women in the 1990s increased to 19 percent nationally, and has remained at approximately this level despite continued efforts to recruit and retain women (National Science Board, 2000, 2004; National Science Foundation, 1998). During the same time, The Dwight Look College of Engineering at Texas A&M University's enrollment of women was 19 percent, mirroring the national average. In 1998, the first Cohort year used in this study, enrollment of underrepresented minority students, defined as African American, Native American and Hispanic students, in the College of Engineering at Texas A&M University was 12.4 percent of all engineering undergraduates (Texas A&M University, 1998).

Though minority enrollment in undergraduate programs had increased for more than a decade, by 2000 baccalaureate (B.S.) degrees in science and engineering were only 7% for Hispanics and 8% for African Americans (Barton, 2003; National Science Board, 2004). A 1997 report by the National Action Council for Minorities in Engineering (NACME) expressed concern over declines in the number of minority freshmen entering the nations engineering schools during the mid 1990s. Reported figures indicate a decline of eight percent since an enrollment peak in 1992-93 (Campbell, 1997). The 1999 NACME report indicates that while Hispanic students have made gains in the number of B. S. degrees in engineering earned, African American and American Indian graduates have declined (Georges, 1999). Degrees awarded to members of these ethnic groups or to women as a group is no where near parity with the percentages of these groups in the population (Goodman Research Group, 2002; Jackson, 2004; National Science Board, 2004; Western Interstate Commission for Higher Education, 2003).

The rigors of an engineering student's coursework are well documented, even back to the foundational 1955 Grinter Report (Grinter, 1955; Harris et al., 1994) that defined the engineering curriculum as it essentially exists today. In addition to a curriculum that is extremely rigorous, students must commit to an engineering major far earlier than other majors. This is due to the extensive pre-requisite of mathematics, science and technology coursework needed to advance to sophomore or upper level courses.

Transfer of credits from and attendance at community colleges has become a predominant factor in higher education as costs and access compel students, particularly minority or first-generation students, to look for cost-saving mechanisms for obtaining a college degree. This has resulted in new factors that impact degree completion by students (Cheslock, 2003; Gao, Hughes, O'Rear, & Willam R. Fendley, 2002; Porter, 2002; Suarez, 2003)

Nationally, most of the studies on student retention and graduation in engineering have focused on academic performance and time to completion. These are predominantly measured by grade point average with particular interest on students in their first year (Astin, 1993; Felder, Forrest, Baker-Ward, Dietz, & Mohr, 1993; Fernandez, 2002; Seymour, 2001; Tinto, 1993; Tobias, 1992). Other works detail the environmental or personal forces that impact student performance and completion rates, particularly of minority students or women (Astin, 1993; Barton, 2003; Bell, Spencer, Iserman, & Logel, 2003; Gardner & Broadus, 1990; Jackson et al., 1993; Moller-Wong & Eide, 1997). Other studies focus on learning communities of students, the science of learning, and the impact of effective instruction on student persistence (Al-Holou et al., 1999; Bucciarelli & Kuhn, 1997; Clough & Kauffman, 1999; Felder, Rugarcia, & Stice, 2000a; Felder et al., 2000b; National Research Council, 1999, 2003; Olds & Miller, 2004; Tinto, 1997, 1999; Tonso, 1996b)

The Dwight Look College of Engineering at Texas A&M University (TAMU) has reviewed extensive data associated with the retention of undergraduate engineering students. Particular attention was paid to women and underrepresented minority students. The focus to date has been on statistical analysis of student performance as it relates to graduation rate, grade point ratio (GPR), the calculus ready status of students, and completion rates of required Core Body of Knowledge (CBK) courses. Comparisons have been made with regard to gender and ethnicity. However, research has not been conducted on the implication of time to complete the required CBK coursework (Rinehart, 2003).

A critical point in the educational path of an engineering student at TAMU is the completion of Core Body of Knowledge (CBK) courses. Undergraduate students enter the College with a lower level classification by meeting university and college entrance requirements, namely high school rank and SAT/ACT scores. Students enrolling for the first time spend their initial year taking foundational courses or what the College terms a Common Body of Knowledge (CBK). Enrollment in subsequent 200 or higher level engineering courses (upper level courses) is restricted to students having grades of "C" or better in all CBK courses. Students will be blocked from upper level courses after a 60 hour limit if the CBK and overall GPR requirements have not been achieved (Rinehart, 2003; Texas A&M University, 1998, 1999).

The CBK is designed to ensure that students advancing to the 200 level upper division coursework have the foundation necessary to successfully perform and complete upper level coursework. Departments within the College view the completion of CBK courses with the required GPR as indication that an engineering student will be capable of successful performance in the 200 level courses. Completion of the CBK courses with the required GPR is necessary to allow students to continue in their chosen major and ultimately graduate.

The required cumulative GPRs for the departments of various majors in this study to automatically advance to upper level are:

Computer Engineering	3.125
Chemical Engineering	3.00
Electrical Engineering	2.75
Mechanical Engineering	2.75
Civil Engineering	2.50

An analysis of time to completion of CBK has not been conducted at TAMU. However, this time factor is critical when one looks at industry's expressed need for more engineering graduates, the foregoing of income by the students, and the accumulation of more education expense or debt by students. An increased time to completion may increasingly affect minority students, due to the significant numbers from lower income families, even though increases in financial aid among all students have been seen (Boehner & McKeon, 2003; Ficklen & Stone, 2002). Thus, minority students are disproportionately represented among students utilizing personal debt to finance their education (Barton, 2003; Ficklen & Stone, 2002; Georges, 1999; Texas Guaranteed Student Loan Corporation, 2004; U.S. Department of Education, 2002a). Further analysis is also needed on the impact of course credits that engineering students transfer into the institution. This includes not only credits for coursework at perhaps a community college, but also credits for courses acquired through scores on nationally administered tests, such as Advanced Placement.

This study will focus on the implications of time to completion of the required Common Body of Knowledge (CBK) courses in the College of Engineering at Texas A&M University (TAMU) for first time entering students.

Statement of the Problem

Departments within the Dwight Look College of Engineering at Texas A&M University (TAMU) currently require a specific overall grade point average (GPA) upon completion of the required CBK courses. A grade of "C" or better must be earned in the CBK courses in addition to the required departmental GPA to advance to upper level status and take courses in the student's designated major. However, the number of semesters necessary to achieve the required CBK and overall GPR is currently not considered. Little research exists in the College of Engineering at TAMU with regard to a student's progress to upper level departmental status as it relates to time to completion of CBK. An analysis of the time necessary to complete the CBK and earn the required departmental GPA is needed, particularly with regard to underrepresented students who are a focus of recruitment and retention by both the College and TAMU.

Purpose of the Study

The purpose of this study is to determine the relationship between grade point average, gender, ethnicity, engineering major, unmet financial need, and transfer credits on time to completion of Core Body of Knowledge courses for first year engineering students at Texas A&M University.

Research Questions

The study will seek to answer the following questions:

1. What is the relationship between gender and time to completion of CBK?
2. What is the relationship between ethnicity and time to completion of CBK?
3. What is the relationship between student unmet financial need and time to completion of CBK?
4. What is the relationship between student major and time to completion of CBK?
5. What is the relationship between cumulative grade point average at time of progression to upper level status and time to completion of CBK?
6. What is the relationship between the total number of credit hours transferred at time of enrollment at TAMU in engineering and time to completion of CBK?

Definitions

Common Body of Knowledge (CBK) is defined as the engineering lower level required courses of General Chemistry for Engineering Students (CHEM 107), Composition and Rhetoric (ENGL 104), Foundations of Engineering I & II (ENGR 111 and 112), Engineering Mathematics I & II (MATH 151 and 152), and Physics (PHYS 218) or equivalent at Texas A&M University (Texas A&M University, 1998).

A **cohort** is comprised of first time students enrolling in the fall semester (1998 or 1999) at Texas A&M University with an engineering major.

Credit hours are for courses accepted by TAMU from other institutions of higher education or through the Advanced Placement (AP, CLEP, IB) credit process .

Success is defined as a student who progresses to upper level status within 60 hours of coursework in one of the five designated departments with unsuccessful being a student who fails to move to upper level status within 60 hours of coursework or complete CBK with the required GPA.

Time to completion of CBK is the number of semesters required for a student to complete the above CBK courses, normally considered to be two semesters with longer than two semesters the usual deviation, i.e., students take longer to complete the CBK. The College of Engineering's policy states "…grades of "C" or better are required in the Common Body of Knowledge. … Students will be allowed to remain as a lower-level student up to 60 hours (provided they are in good standing and making progress). At the 60-hour limit, students will be blocked from further registration in that department if the CBK and overall GPR requirements for upper division have not been achieved" (Texas A&M University, 1998).

Transfer credit is defined as transfer credit on course work completed and accepted at the time of application to Texas A&M University (Texas A&M University, 1998) .

Underrepresented minority students are those declaring race or ethnicity as African American or Hispanic.

Unmet financial need is defined as a student qualifying to receive financial aid, based on calculations by the TAMU Office of Student Financial Aid.   Students not applying or qualifying for financial aid will be determined not to have Financial Need.

Limitations

This research is applicable to engineering students of the Dwight Look College of Engineering at Texas A&M University. The findings may not be generalized to another institution of higher education or race or ethnicity groups.

Significance of the Study

The national focus on graduating more B.S. engineers, along with the demographic shifts among growing populations of women, African Americans and Hispanics, has caused many colleges of engineering to review the issues involving recruitment and retention of U.S. undergraduate students. Much of the TAMU engineering student's first year of coursework provides the required CBK courses, which allow entrance to 200 level engineering courses. At present, departments in the Dwight

Look College of Engineering at TAMU focus only on attainment of a certain GPR in these CBK courses for students to be allowed to enroll in 200 level courses. Review of the time to completion factor of CBK is needed by the College in order to ensure that departments are addressing all elements that impact student success in achieving upper level departmental status and successfully completing an undergraduate degree.

The study will provide 1) insight into the question of whether time to completion of CBK is a valid consideration for departments to make when allowing students to enroll in upper division engineering courses; 2) information on whether differences exist in completion time of CBK based on gender, ethnicity, cumulative grade point average, engineering major, financial need, or transfer credits; and 3) a contribution to the retention studies of the College.

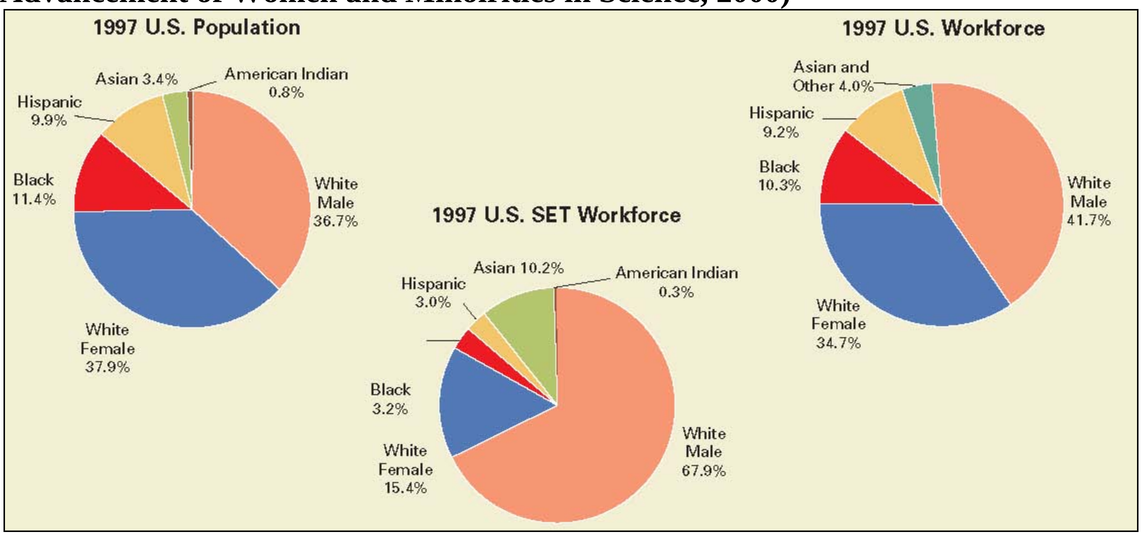
CHAPTER II

REVIEW OF THE LITERATURE

Foundational research has been conducted on student retention and matriculation in higher education in general (Astin, 1977, 1984, 1998; Terenzini & Pascarella, 1994; Tinto, 1993; Tobias, 1990; Tobias, 1992) and specifically related to student ethnicity, gender and financial need (American Society for Engineering Education, 1994, 2004; Georges, 1999; U. S. Department of Education, 2002b). Studies on the modifications and reform efforts in engineering education have also been conducted, particularly with regard to issues of student retention (Alford, 1999; Astin, 1993; Bell et al., 2003; Felder et al., 1993; Gardner & Broadus, 1990; Jackson et al., 1993; Matyas & Malcom, 1991; Moller-Wong & Eide, 1997).

The past decade has seen global competition, declines in engineering enrollments, and demographic shifts in the population at the same time industry is asking for a better prepared workforce. The 21st century engineer still needs a quality educational experience in the foundational engineering tools and concepts of mathematics and science. Employers also desire that engineering education encompass a new set of tools and skills that enables teamwork and communication, and they seek to draw from the increasingly diverse workforce population (Brainard, 1999; Felder et al., 2000b; Rugarcia, Felder, Woods, & Stice, 2000c; Wulf & Fisher, 2002). A report by the Congressional Commission on the Advancement of Women and Minorities in Science (2000) recommended greater focus on women, minorities and persons with disabilities, since these groups constitute more than two-thirds of the domestic workforce, yet were groups underrepresented in the science, engineering and technical (SET) workforce. Figure 1 below compares the 1997 U.S. population, overall workforce, and Science, Engineering and Technology workforce by ethnicity and gender.

Figure 1: Workforce Population Comparison (Congressional Commission on the Advancement of Women and Minoirities in Science, 2000)



Very little information in the research literature relates to a common body of knowledge in an engineering curriculum. Nor does it relate to the "time to completion" of required courses, student performance, or movement to upper-level engineering discipline specific coursework. The CBK completion issue is somewhat unique to TAMU, though nationally colleges of engineering require similar courses to those included in TAMU's CBK as pre-requisites to taking upper level engineering coursework (Accreditation Board for Engineering and Technology, 2004). This would be coursework related to specific engineering disciplines or degrees. Such a study is relevant to engineering programs at most major universities. This is particularly true for the larger research institutions with colleges of engineering.

National Demographics and Enrollment in Higher Education

By 2005, almost 28 percent of the U.S. workforce will be comprised of minorities (Carnevale & Fry, 2000). These national demographic shifts have put great focus on the need for higher education to increase the enrollment and retention of minorities. While there has been increased enrollment within these populations at colleges and universities—particularly among women in the life and physical sciences—there has not been the same increase in engineering enrollment and degree attainment (National Science Board, 2000; National Science Foundation, 1999a, 1999b).

During 1999-2000 a U.S. Department of Education study indicated there were approximately 16.5 million undergraduates enrolled in institutions of higher education across the United States. Women comprised 56% of total enrollment and minorities were almost 33% of total enrollment. The minority breakdown includes 12% African American, 11% Hispanic, and 5% Asian (U. S. Department of Education, 2002a). In comparison, the national engineering enrollment for 1999 was 7% African American, or 25,419 students of total 361,395 enrolled; 8% Hispanics, 29,111 of total, and 11% Asian, 39,891 of total (National Science Foundation, 2003).

Given that one of the most significant means of increased earning power is a college education, the following statistics are troubling: A U.S. census report indicated that Hispanics constituted 8.2% of associate degrees; 5.6% of bachelor's degrees; 3.8%

of master's degrees; 4.5% of first-professional degrees; and 2.8% of all doctorate degrees awarded in 1998 (U. S. Bureau of the Census, 2002).

A 1998 study by Astin on thirty years of college freshmen attitudes, suggests that the women's movement changed the education plans and career aspirations of women, along with societal attitudes on the role of women. He confirms data indicating an increased number of women pursuing advanced degrees and significant increase in women entering traditionally male-dominated careers of medicine, law, and business compared to a declining interest by women in teaching and the arts. A modest increase was seen in women's interest in engineering careers, as was a decline in male interest, so that by 1996, there was a similarity in men and women's educational and career aspirations.

Minority populations accounted for almost all of the relative growth in college enrollment from 1980-2000. Participation rates by 18-24 years old high school graduates varied by ethnicity and gender, and could also be linked to the high school completion rates of each ethnic group. During a twenty year period, college participation rates increased for white and African American males and Hispanic females but remained stagnant for Hispanic males. The 1990s saw the greatest gains by African Americans with the 1980s showing the greatest gains in participation by Hispanics. Hispanic enrollments increased 10.8% from 1999-2001 with most of the growth occurring at two-year institutions, or community colleges (American Council on Education, 2003).

Astin (1982) defined the 'leakage points' of an educational pipeline for minority students as high school, college entry, college completion, graduate school entry and graduate school completion. His research documented disadvantaged minority attendance and persistence in higher education and the high attrition rate of Hispanics and African Americans, attributing a great deal of the drop out factor to K-12 quality and student preparation issues. Another issue affecting these students includes parental income because lower family income lessens a minority student's chance at obtaining a four-year degree. Attendance at two-year institutions (community colleges) had a much higher representation of minorities than the general population in higher education. This study documented that the single most important factor contributing to the underrepresentation of Hispanics and Native Americans among bachelor's degrees attained was the high attrition rate from high school and a greater than average attrition from college (undergraduate). It also indicated the most severe underrepresentation of minorities was in the fields of engineering, biological sciences, physical sciences and mathematics. Astin (1982) advocated further study to indicate whether lack of interest, exposure, or preparation kept students from enrolling in these majors and subsequently entering employment in these fields.

Texas Demographics and Trends in Higher Education

Texas has one of the fastest growing populations in the U.S., especially regarding the substantial growth in the state's Hispanic population (Alford, 1999; Murdock, 1996). Although there have been increases in college and university minority enrollment, minorities are not attaining four-year degrees in the same proportion as their population growth (American Council on Education, 2003; Roser, 2000; U. S. Department of Education, 2002a). This could have a significant negative impact on the state's potential competitiveness, particularly in the areas of science and engineering fields where minorities and women remain underrepresented in proportion to the general population (Alford, 1999; Goodman Research Group, 2002; Jackson et al., 1993; Matyas & Malcom, 1991; McGraw, 1999; National Science Board, 2004; National Science Foundation, 1998; National Science Foundation, 2003). Furthermore, the rapidly rising costs of a college education are also reducing minority enrollments (Georges, 1999), potentially effecting student attendance at four-year institutions, and significantly increasing the loan amounts upon graduation of minority students (Georges, 1999; Texas Guaranteed Student Loan Corporation, 2004; U.S. Department of Education, 2002b).

A 2003 study by the Educational Testing Service (ETS) assumed that the stagnant enrollments caused by the baby boomers passing college age will end and new growth is expected via the students of Generation *Y*. These are individuals born between 1982 and 1996 who are currently enrolling in college. Over the next two decades ETS projects the number of undergraduates to grow by 19 percent. By 2015, 80% of the growth of an additional 2.6 million new students is projected to be minority - African American, Hispanic, and Asian Pacific Islander. Hispanics will register the largest increases—from approximately 10% to over 15% in 2015. Texas will be heavily affected, with the campus populations for the state anticipated to be 50% minority by 2015 (Carnevale & Fry, 2000).

Population and economic statistics indicate some special problems for Texas and other Southwestern states where minority populations are predominantly Hispanic, who are projected to lead population growth during the next 40 years. In 2000, the state's population was younger than the U.S. average—32.3 years for Texas compared to 35.3 years for the U.S. (Murdock et al., 2002). There will be more Hispanics in K-12 than any other group in the coming years, and despite drop-out issues they will remain one of the largest pools of high school graduates seeking employment or enrollment in higher education (Barton, 2003; Western Interstate Commission for Higher Education, 2003).

Hispanics in Texas have a much lower median age and much higher poverty rate as compared to other groups. Median household income for African Americans and Hispanics was two-thirds that of White households. Projections also indicate median earnings for Hispanics will fall due to their rapidly growing population unless changes are made to their earning power (Murdock et al., 2002).

A study by Astin in 1982 indicated that minorities were greatly underrepresented in flagship universities throughout the U.S. Texas A&M was one of the four top flagships institutions, along with Clemson, Auburn, and Virginia Polytechnic Institute, showing significant under representation of African American and Hispanic undergraduates compared to these groups' populations in the state. Astin pointed to the fact that these institutions emphasize science and engineering and that TAMU was a technologically oriented university, yet African Americans and Hispanics tended to avoid enrolling in these majors (Astin, 1982). However, these numbers have changed significantly so that for 2001-2002, *Hispanic Outlook* listed TAMU as one of the top 20 institutions awarding bachelor's degrees to Hispanics and number 6 in doctoral degrees awarded to Hispanics (Hispanic Outlook, 2004).

Recruitment and Retention of Students in Higher Education

The literature identifies three primary mechanisms for maintaining or increasing university enrollment: 1) enrolling a larger portion of the available pool of students, traditionally graduating high school seniors; 2) targeting a more non-traditional pool, often minority first-generation students; or 3) increasing retention. For more than 25 years, the attrition of students, and particularly that of minority students, has been a concern of university educators. Research aimed at remedying this problem focuses on mechanisms for reducing student attrition and thereby increasing student retention (Astin, 1975; Beal & Noel, 1980; Lenning, Beal, & Sauer, 1980). The loss of students from a degree path or enrollment at a university results in a waste of time, energy, and finances for students and the institution, and can be discouraging for the student, who often finds it difficult to reestablish his or her momentum in higher education.

Foundational work by Lenning, Beal and Sauer (1980) overviews research on student attrition and the various intervention methods used to retain students. There is also significant work by known educational researchers such as Tinto (1988, 1993; Tinto, 1999, 2000), Astin (Astin, 1975, 1977, 1984, 1998), Pascarella, and Terenzini (1994). Much of the research focuses on results attributed to student characteristics and preparedness and on institutional intervention programs. Researchers (Lang, 2001; Lenning et al., 1980) surmise that commitment across all levels of the university and at all points where students interact with the institution are critical for successful retention programs. Successful efforts normally have support from top-level administration, and those that fail lack the involvement of faculty and the entire institution. Further, minority student retention rates have improved on campuses where retention programs address student issues inside and outside of the classroom (Astin, 1982; Lang, 2001). Industry also report that efforts at creating a diverse workforce is only successful when commitment comes from upper management (Brainard, 1999).

Tinto (1999) theorizes that students enter college with varying backgrounds of personal, family, and academic characteristics and skills. Pascarella (1999) suggests that student change is also affected additionally by the institution of higher education environment and characteristics (selectivity, size) and the quality of student effort all interacting and influencing each other. Astin's seminal work includes longitudinal studies of college student dropout and subsequent studies that seek to refine those identified factors affecting student persistence in college. An initial study concluded that entering freshmen at the greatest chance of dropping out were those with poor academic records in high school, low aspirations, poor study habits, relatively uneducated parents, and were from small town backgrounds. Working full time decreased persistence among all groups of student, those working on campus part-time (less than 20 hours) reduced the risk of drop-out. The strongest relationship existed between Grade Point Average (GPA) and persistence (Astin, 1975).

Astin reports differences between stated reasons for dropping out between African Americans and whites (Astin, 1975, 1977, 1984, 1998; Astin & Panos, 1969). One significant point is that the assumption that students dropped out due to academic difficulty did not necessarily hold true. For example, Astin and Panos (1969)one study found that almost 75% of dropouts did so voluntarily rather than being forced to leave due to academic difficulty. Additional risk factors that might affect retention include working full time, starting at a community college, and having parents who did not attend college. Financial issues (often reflecting a student's need to work) contribute to difficulties with undergraduates remaining in college to obtain their bachelor's degree (Astin, 1975; Choy, 2002).

Most studies focus more on student factors and less on interaction and the fit between students and the institutions they chose to attend. Lenning (1980) cites four factors which affected student departures and retention: 1) student characteristics, such as academic background, demographics, and financial factors; 2) institutional characteristics; 3) interactions between the students and institutional characters and the mis-matching of the two; and 4) external forces (also termed environmental factors), such as family, culture, and the economy. Beal and Noel (1980) define prominent factors affecting student retention as: 1) student characteristics - inclusive of academic background, demographics, and financial factors; and 2) environmental factors - type of school, student academic, counseling and advising services, and student involvement.

Texas A&M University Measurement and Research Services conducted a survey on students enrolled in Fall 1998 that did not return to TAMU in spring 1999. Compared to respondent data at other universities who took the same nationally normed survey, TAMU survey respondents cited different reasons for not returning to campus. Students selected had grade points that would have allowed them to return to TAMU.

Differences between gender and ethnicity were noted among TAMU responders, although the number of responses for minority students was low and Hispanics, Black, and other were combined to form the minority category. Women cited personal reasons such as family and emotional well-being over the males' reasons of academic reasons such as instruction or grades. Minority indicated tuition and expenses along with impersonal attitudes and familial influence as critical factors; whereas, Anglos assign greater important to major area of study, emotional well being, including marriage and family and employment (Troy, 1999).

Standardized tests such as the SAT and ACT tests have long been used as criteria for entrance into institutions of higher education with the perception that the selection of a higher score increases student performance and retention. However a new 20 year study by Bates College in Maine (Hoover, 2004) of its SAT-optional admission policy finds "virtually no difference between the subsequent academic performance" of students who had submitted SAT scores versus student who did not submit scores. The institution has doubled its applicant pool since it stopped requiring the SAT, significantly increasing application by women, minorities, financially needy and learning disabled students. 49% Hispanic, 45% African American and 30% of white students did not submit test scores. The graduation rates of students submitting scores and those not submitting differ by just one-tenth of 1 percent (Hoover, 2004).

Engineering Enrollment in the U.S.

Since 1980 Science and Engineering (S&E) jobs have increased at four times the rate of other jobs in the US (National Science Board, 2004). However, less than 50% of undergraduates entering college to major in science and engineering will complete a degree in these fields within five years. The data also show that students from minority groups drop out at a higher rate than other groups (National Science Board, 2002). To achieve the technical workforce needed in the U.S., improvements must be made to the success of ALL demographic groups in science and engineering

Nationally, two percent of women enrolled in four-year colleges majored in engineering as compared to 11% of men (U. S. Department of Education, 2002a). Reports compiled by the National Science Foundation indicate after two decades of decline, the 1990s saw an upward trend in college enrollment with expectations of growth from 18.5 million in 2000 to 21.7 million by 2015. Between 1992 and 1998, overall enrollment rose by one percent, with underrepresented minorities increasing by 16% and Asian/Pacific Islanders by 36%. The largest increases in enrollment are projected to come from minority groups, primarily Hispanics (National Science Board, 2004; U. S. Department of Education, 2002a).

Retention of Engineering Students

Longitudinal cohort studies of student performance and retention along with efforts at enhancing the engineering curriculum have indicated that student academic success increases retention, and meets industry's desire for a curriculum that prepares engineers for the 21st century. A number of researchers have conducted studies on factors in engineering that affect student success, including: academic preparation, faculty and student interactions; changes to an integrated curriculum with industry applications; and the use of enhanced instructional strategies (cooperative or active learning) and community building among students, such as learning communities (Felder et al., 1993; Felder et al., 2000a; Gabelnick et al.,1990; Rugarcia et al., 2000; Stice, Felder, Woods, & Rugarcia, 2000c; Woods, Felder, Rugarcia, & Stice, 2000b).

Of particular interest is Felder's (Felder et al., 1993) cohort longitudinal study of student performance and retention in an introductory chemical engineering course which compared issues of gender, hours worked, academic preparation, use of time, student self-perceptions, and personality type via the Myer's-Briggs Type Indicator (MBTI). Like the TAMU engineering program, students in the study had to pass the introductory (first year) courses to proceed to the upper level chemical engineering curriculum. The study found correlations for various college admission criteria that are typical to many retention studies and include: SAT mathematics and verbal scores, and freshman year grades (overall GPA, grades in calculus, chemistry, physics, and English courses). The probability of passing the course with a C or better was greater for students from urban or suburban communities (80% of 65 versus 54.6% of 55 from rural towns), who spent fewer than 10 hours per week devoted to an outside job (72% of 94 versus 56% of 25 working 11 or more hours per week), had fathers with educational levels of some college (80% versus 36% of those with fathers never attending college), and greater for MBTI intutitors (82% of 49) than for sensors (63% of 67). There was also a positive correlation to the weighted class average with SAT mathematics ($r=0.47$, $p<0.001$) and verbal ($r=0.29$, $p=0.0054$) scores, freshman year grade point average ($r-0.66$, $p<0.001$), and grades in selected freshman mathematics ($r=0.62$, $p<.0001$), physics ($r=0.62$, p<0.001), chemistry (first semester r=0.47, p<0.001 and second semester r=0.61, p<0.001), and English courses (r-0.26, p=013).

Researchers address aspects of student retention or persistence in engineering based on general student models such as Tinto (Jackson, Garner, & Sullivan, 1993), Astin, and Pascarella and Terenzini (1991). The majority of these were cohort longitudinal studies, which will also be the model for this study. Cohort studies are prevalent in student retention studies and studies of interventions with a defined group, often in comparison to a similar group, for instance smokers compared to non smokers over period of time, or incoming freshmen exposed or not exposed to an academic enhancement program (Ibrahim, Alexander, Shy, & Farr, 1999).

Astin (1993) profiles engineering student retention factors. The study indicates that retention is even more critical with engineering majors than perhaps with other fields of study, since the majority of students completing an engineering degree are those who started out majoring in the field. Students choosing engineering majors had fathers who were engineers, rate themselves high in mathematical ability, had good grades in high school, high SAT scores on the math portion, and expressed a strong interest in science when entering college. The percent of peers also majoring in engineering was the most important environmental factor affecting a student choosing to major in engineering. Further, the greatest loss among engineering majors is in the undergraduate years, with a net loss of 43% between the freshman and senior years. Engineering majors indicated a greater dissatisfaction with their major than non-engineering students who participated in the study, which Astin ascribes to the academic rigors of the major and its negative effect on grades, along with the longer length of time to complete an engineering degree. Further aspects of dissatisfaction were expressed about the faculty's use of lectures rather than the classroom discussion and cooperative learning seen in other academic areas, grading on the curve, and the use of graduate teaching assistants rather than faculty instructors (Astin, 1993).

Studies (Felder et al., 1993; Jackson et al., 1993) on retention in engineering have used quantitative and qualitative measures to characterize "persisters," those who remain engineering majors, and "non-persisters," those who leave engineering for other majors. Results indicate that persisters in engineering are most affected by their own individual makeup, association with faculty, and their campus academic and social support structure. Other past, present and future influences also affected a student's decision to remain an engineering major; past factors include background, cultural and familial characteristics, and academic preparation. Present factors involve aspects of faculty interaction, along with availability and use of academic and social support programs. Future factors include student expectations for career objectives, such as salary or work/life balance.

Engineering colleges counsel students that engineering majors need strong academic preparation in mathematics and science for success in the field, particularly during a college student's first year. Using factor analysis, Jackson (1993) argues that freshmen grade point average ($R=.39$ with $R=.36$ females and $R=.42$ for males)—a present factor—to be the most important distinguisher or predictor of persistence for an engineering major. Persisters in this study were more aware and linked to student support services and activities such as tutoring, faculty advisement and student organizations. Women benefited more than males from these services and took more advantage of them ($p<.05$ for all of the x^2 statistics). Future factors distinguishing between the two groups included expected salary and long-term career objectives, with both being more significant among the persisters (Jackson et al., 1993).

A 1990 study by Gardner and Broadus discusses academic, social, and psychological differences between those who persisted in engineering and those who transferred to another major after initially enrolling in engineering. Particular focus and attention was given to minority students and women. The study detailed high school preparation and factors influencing the initial discussion to opt for engineering major, including external and internal factors, role models and activities. They also compiled relevant engineering experiences including study, social and work time and surveyed students' expectations and discrimination, and academic performance. Seeking help was also reviewed as a factor contributing to student persistence or departure. Analyses suggest that leavers differ from persisters with regard to lower academic performance, less defined career goals, and had less commitment to the major. Grade problems further enforced the decision to move out of an engineering major, with mathematics the primary reason for academic difficulties, rather than a loss of interest in engineering. Students changing majors also appeared to need more mentoring support or faculty interaction. Women persisted well overall but felt ignored and less accepted in the male dominated field. African Americans indicated the most personal frustration over their abilities to succeed in the engineering environment (Gardner & Broadus, 1990).

Research indicates that other factors impacting a student's desire to remain an engineering major, included personality type, the engineering academic environment, learning style, and pre-existing knowledge or misunderstanding of foundational math and science concepts (Felder et al., 2000b; Gabelnick et al., 1990).

Graduation Rates in Higher Education and Engineering

A closer examination of graduation rates helps to show whether the demand for B.S. engineering graduates will be met. A report by the National Science Foundation (1999) indicates bachelor's degrees granted in the United States and its territories increased from 524,008 in 1966 to over one million in 1996 (1,179,815). The number of students earning bachelor degrees in science or engineering fields from 1966 to 1996 more than doubled from 184,313 to 384,674. However, the percentages compared to total degrees granted actually declined during this same time from 35.2 percent to 32.6 percent (National Science Foundation, 1999a).

In 1996, over 55 percent of all bachelor's degrees awarded went to women. Though the number of engineering degrees awarded to women increased over a twenty year time-period from less than one percent to almost 18 percent, the peak number of degrees awarded, 11,246, occurred in 1985. After this time degrees granted declined until 1993 then slowly climbed to slightly above the 1985 highpoint to 11,316 in 1996. Clearly, the number of degrees awarded to women in engineering does not reach parity with bachelor degrees awarded to women in other fields (National Science Foundation, 1999a).

In 1997 the number of engineering degrees began to decline, with the exception of computer science, which rose dramatically. The number of degrees earned by white students declined from 87 percent in 1977 to 68 percent in 2000, though degrees earned by underrepresented minority students increased, but not at a similar rate to cover losses in the white population participation. Though there has been some growth in the number of degrees granted to women and minorities, the ratios of bachelor's degrees to the 24 year old population in natural science and engineering fields has increased less than one percent for African Americans (1.6% in 1990 and 2.6% in 2000) and Hispanics (1.5 % in 1990 to 2.3% in 2000). Women receiving natural science and engineering degrees during this same time period increased from 2.8 to 4.5 percent (National Science Board, 2004).

The undergraduate enrollment of underrepresented minorities increased slightly during the decade, but by 1995 only about 7% of African American and 6% of Hispanics earned B.S. degrees in science and engineering (Committee on Equal Opportunities in Science and Engineering, 1998). Table 1 indicates that as of 2000, degrees among African Americans and Hispanics continue to rise from the 1990 numbers (National Science Board, 2004). In 2002, African Americans received 5.1% of the bachelors' degree in engineering awarded in engineering and Hispanics received 5.4% compared to 68.3% for Caucasian and 14% for Asian American (American Society for Engineering Education, 2004).

Table 1
B.S. Degrees Granted by U.S. Institutions
(*Science and Engineering Indicators 2004* p. 2-20)

1990 and 2000 Degrees Awarded	**All BS Degrees**	**All S& E Degrees**	**% of Total for S&E Degrees**
1990 Total	1,062,160	345,794	
Male	495,876	199,917	58%
Female	566,284	145,877	42%
White	856,686	270,225	78%
Minority (all)	107,377	33,419	10%
African American	59,301	18,230	5%
Hispanic	43,864	13,918	4%
2000 Total	1,253,121	398,622	
Male	536,158	197,669	50%
Female	716,963	200,953	50%
Minority (all)	200,967	63,519	16%
African American	104,212	32,924	8%
Hispanic	88,324	27,984	7%

Issues for Special Populations

While there are some common issues discussed above regarding the persistence and success of students in higher education and specifically as engineering majors, some groups have special issues relating to recruitment and retention. In engineering, women and three ethnic minorities are the primary focuses when discussion of increasing diversity and numbers occur. These groups are underrepresented in engineering as compared to their percent of the general population and those enrolled in other college majors. Along with women the three ethnic minorities considered underrepresented in engineering are African Americans, Hispanics and Native Americans. A focus of this study is related to research on Hispanic students due to their increasing population in the nation and state where the institution is located and student data was obtained.

Issues for Women Engineering Students

Gender is a factor that has been studied regarding engineering recruitment and retention. Reports indicate that women make up over 56% of the total U.S. workforce but only 8.5% of engineers are women (Goodman Research Group, 2002). Nationally women have surpassed men in college enrollment and are receiving more than 50% of all bachelor's degrees (U. S. Department of Education, 2002a), yet women are less likely than men to choose a science or engineering field, other than in the biological sciences. Data indicate that women do not have a higher attrition rate in science and engineering majors than males, but they are still only 20% of those who choose to major and subsequently graduate in engineering (National Science Foundation, 2003). Even with the rise in enrollment of minorities and women in higher education, engineering enrollment overall has been on the decline or stagnant for decades now. It has not traditionally attracted women and minorities to its ranks and enrollment for these groups appears to also be stabilizing or leveling off despite efforts to better recruit and retain students (Brainard, 1999; Campbell, 1997; Jackson, 2004).

Current trends raise concern over the declining numbers and percentages of women in computer science and minorities in engineering. Students majoring in computer engineering—one of five engineering majors selected for this study—are often in computer science departments as many of the computer engineering degrees originate from computer science departments. The percentage of women receiving degrees in computer science has decreased from 37 percent of bachelor's degrees granted in 1984 to 28 percent in 1996 (National Science Foundation, 2000). In a study of 53 institutions with colleges of engineering, the Goodman Research (2002) group found that first year and sophomore women engineering students were the most likely to leave.

Nationally known for her work on issues in science, mathematics, and engineering, Elaine Seymour (Seymour, 1999, 2001; Seymour & Hewitt, 1997) advocates systemic change in the education of engineers and scientists in order to attract others than the white male who has traditionally populated these fields. The need for systemic change is also advocated by Tobias (Tobias, 1990, 1992). Seymour (1999) theorizes that socialization of females versus males significantly affects the reason students enter and remain in these fields. Pre-college encouragement or discouragement, male behavior in courses, and the acculturization of women to perform for others were factors brought out by her studies. Women often don't talk about how they were treated, and worry more about work and family issues as they matriculated to the senior year. Seymour (2001) documents shifts in emphasis or thinking in higher education that include a greater emphasis on science for all and a shift from "teaching" to "learning", with an overarching theme focused on assessment of projects and programs.

A study comprised of seventeen engineering colleges at a diverse set of institutions (public, private, small, large) on the attitudes of entering freshman engineering students and change during their first year indicated statistical differences by gender and ethnicity. Female engineering students had lower confidence in their abilities to succeed in the major and with regard to their academic background than their male counterparts. Their perceptions of the contributions engineers make to society were also lower than that of males. The same female students were however more comfortable with their study habits than were the male students. Hispanic students at five of the seven engineering schools were more favorably disposed to *Working in Groups* than were majority engineering students. Significant attitudes were found for Blacks students as compared to Asian and Hispanic students, with attitudinal differences that were significant for Black and Hispanic student relative to majority students positive in nature, such as the working in community groups (Besterfield-Sacre, Moreno, Shuman, & Atman, 2001).

Another study indicates how the stereotype threat may interfere with women's classroom performance (Bell et al., 2003). Research on test and classroom performance of women was compiled using the Fundamentals of Engineering (FE) exam questions under various situations to test the theory that stereotype threat interferes or negatively affects women's performance. Stereotype threat is a situation where a student is risking negative judgment to a "commonly held stereotype that exists about one's group… [which] interferes with one's performance (p. 307). This study indicates that such a "predicament creates pressure that leads to performance degradation" (p. 308). When statements in the testing allude to negative stereotypes in women in engineering fields, the results note differences in performance between women and men. Conclusions were that "women's performance is significantly lower when stereotype threat is high". Studies by Tonso (1996a; Tonso, 1996b, 1999) support this conclusion, indicating that the predominantly male culture differentiates women, and women are seen as having to adapt to the engineering culture rather than have their needs and interests considered.

A qualitative study by Tonso (1996b) uses ethnographic and situated learning theory methodology to inform the social issue of women's learning and performance in groups or teams for a required engineering design course. Her theories suggest that learning is a process of moving from novice to expert and that the process is marked by a person's identity, and by past experiences that influence how they view themselves and team members in the process. Results indicate significant progress of students' use of terminology and dramatic increase in ability to explain following required writing of reports. Other gains included gaining conceptual understanding and abilities to function as an engineer on a team. The classroom setting and faculty actions form the values for student identity as did the formation—or not—of teams. A critical finding is that being the only woman on a team is a substantial disadvantage, and that including at least two women on any team is preferred. Fragmenting the team's knowledge into areas of expertise should be avoided in order to "authenticate" the collaborative experiences. Tonso also indicates that it is important for all students, but particularly women, to understand the value of their work, perhaps by demonstrating how prior student projects had been used by public or private sector entities.

In summary, it appears that women are attracted to engineering in lesser numbers than other undergraduate degrees and that they leave engineering for reasons other than academic under-preparedness or failure (Seymour & Hewitt, 1997; Tobias, 1990).

Issues for Minority Students

With the significant focus being placed on science, technology, engineering, and mathematics (STEM) as the skill sets needed in the 21st century, researchers have looked at issues of student retention in these fields, including those attributes that mirror or conflict with the general assumptions for the general college student population (Association of American Colleges, 1985; Matyas & Malcom, 1991; Tinto, 1993).

Minority students historically are underrepresented in higher education, particularly at four-year institutions. The significant demographic shift from a predominantly white toward a growing and young minority population in the past ten to fifteen years has led to targeting this pool of students for enrollment and retention in higher education, and in particular for these groups and women in engineering and the sciences (Association of American Colleges, 1985; Astin, 1982, 1998; Committee on Equal Opportunities in Science and Engineering, 1998; Jackson, 2004; National Science Foundation, 1999a; Vernez & Mizell, 2001).

Minority students do not enrolled in college at the same levels as women, so only 30% of all undergraduates in 1999-2000 were minorities, which included Asians as a minority group in higher education (Choy, 2002). This despite the fact that Hispanics, as the largest and fastest growing population in the U.S., will be relied on heavily to fill the future need for engineers and scientists (Barton, 2003). In engineering, Hispanic and African American enrollment has increased while white enrollment has decreased slightly, but these two groups underrepresentation among engineering majors is still very evident (National Science Foundation, 2000). Underrepresented minority students in science and engineering are also more likely than others to drop out of these majors (National Science Board, 2004).

Nationally, African Americans and Hispanics are most likely to be first generation students (i.e. their parents had no more than a high school education) (American Council on Education, 2003). They are also the fastest growing percentages of the U.S. population under 25 years of age, yet are the least likely to attend college. Increases in college enrollment are projected to come from minority groups with Hispanics projected to be the largest increase of 52 percent from 2000-2015, despite the fact that a majority of these students have, and will continue to be, enrolled at two-year institutions or community colleges (National Science Board, 2004; Vernez & Mizell, 2001).

A student's likelihood of attending a four-year institution increases with the level of parental education, even for the highly qualified high school senior. One aspect that increases a student's persistence toward a degree is taking a rigorous high school curriculum, particularly in science and mathematics (Barton, 2003; Choy, 2002). This coursework applies particularly to preparedness in an engineering curriculum. However, underrepresented minorities often do not have the rigorous K-12 academic preparation and the majority are first generation to graduate from high school, with few parents having attended or completed college (American Council on Education, 2003; Lenning et al., 1980; Murdock, 1996; Olivas, 1986; Western Interstate Commission for Higher Education, 2003).

Ford's (1996) edited book on successful retention models found recurring themes associated with perceptions that minority students received special admissions and were therefore less qualified to attend a university than their white peer students. Issues of a new environment and culture also led students to leave higher education to take jobs that could assist their often financially needy families. Interventions varied from campus to campus, but common approaches included faculty involvement and mentoring of students, attempts to build a community among students, particularly minority students, and academic enhancement programs. Other unique aspects included understanding cultures and communities from which the student came and involving parents and family members in a better understanding of the expectation of higher education institutions.

Clearly, student background and personal characteristics combine with influences and interactions on a campus to affect retention. Fleming and Moore (1998) found that SAT scores produced a low correlation with semester grade, and did not correlate with first semester grade point average (GPA). Relationships to faculty and a sense of community among students are important factors in student success, particularly for minority students. Minority males appeared to suffer the most from lack of high school teacher guidance, whereas minority females had more difficulty with college instructors. Results of this study indicate that SAT scores may not predict grades consistently among minority students, mentoring by teachers and faculty can have a positive impact on retention and performance, and preparedness is not the sole issue in academic failure of minority engineering students (Fleming & Morning, 1998).

Student retention, predominantly of first and second year students and underrepresented minorities (African Americans, Hispanics, and Native Americans), was seen as a problem for colleges of engineering, since these groups were not being retained at numbers equal to their white counterparts in college. In the late 1980s and 90s the focus was on the significant drop in the enrollment of African American students in college and their high attrition rates. As demographics changed in the 1990s and Hispanics were projected to become the largest minority population, there has been an increased research focus on this minority group. Neither Hispanics nor African Americans enroll in college at a rate comparable to white undergraduates, and their matriculation to degree averages less than that of their white peers (National Science Foundation, 1999a, 1999b; U. S. Department of Education, 2002a).

A significant shift in African American student enrollment occurred between 1960 and the 1980s. In 1960, 96% of African American college students were enrolled at Historically African American Colleges and Universities (HBCUs). By 1984, 19% of African American students were enrolled in higher education at HBCUs, and in 1988, 66% of African American graduates were awarded degree from universities that were predominantly white (Neisler, 1992). Fewer African American students are completing high school. This and the higher than average drop out from college are both contributing to the lack of African American representation of degrees awarded not mirroring the percent of African Americans in the population. Many factors contribute to the attrition of African American students, from the tangible lack of financial resource due to disproportionate poverty status of African Americans, to the lack of parental knowledge and skills to navigate the higher education system. However, many researchers recommend that academic and social support communities need to be developed and used by African American students to enhance both their academic abilities and their retention. These communities eliminate some of the feelings of isolation that many African American students have on majority white campuses and also increase persistence levels (Lang & Ford, 1992). Treisman (1992) also found that building a community of learners among minority students greatly increases their persistence and academic performance.

Brown (1996) indicates that loss of African American students from higher education is attributed to 1) poverty and lack of role models 2) deficits in K-12 academic preparation; increased requirements for college enrollment; 4) increased use of admission tests (SAT, ACT) and 5) shifts in financial aid packaging to loans versus grants. Factors for Hispanic students include poor K-12 preparation, insufficient financial aid, transition and adjustment problems, family circumstances, and inadequate support services (Barton, 2003).

Olivas (1986) put forth and edited a book on the issues facing Hispanic students in the educational pipeline. The series of articles cover students from the elementary and secondary school levels (grades K-12) to the transition into higher education through community colleges or four-year institutions. It is important to note that studies during this time-frame subdivide student ethnicity data into Mexican American, Puerto Rican, and Cuban, which today is normally aggregated under the all encompassing category termed Hispanic. In summary, the research shows that Hispanic students were significantly underrepresented in higher education due to their high attrition rate in secondary or high school, and that the majority of Hispanic students are concentrated in two-year institutions. It notes the large number of immigrants and the impact of language issues on students not speaking English as a primary language and the linguistic complications this imposed on students during classroom and standardized testing. It also documents the negative impact that poverty, lack of quality education and college preparation coursework, and lack of family with college experience or degrees have on the Hispanic student. These constraints are also documented in a report by the American Association of University Women Educational Foundation (Ginorio & Huston, 2001).

The issue of the majority of Hispanics in higher education being enrolled in community colleges is documented by other researchers and still remains as indicated by 2002 data (National Science Board, 2002; U. S. Department of Education, 2002a). Further, the majority of Hispanics ages 24 and under live in a few states: California, home to 1/3; Texas at 20%; and another 25% combined from New York, Florida, and Illinois (Vernez & Mizell, 2001).

Also, differences in students' learning styles, culture, support structure, and knowledge of the university system all have an impact on minority students, often a negative impact (Fleming & Morning, 1998; Jackson et al., 1993; Jackson, 2004). For example, studies of field dependent and independent learners indicate that Mexican American students (the predominant category of U.S. Hispanics) face a cultural gap from white students, predominantly in cognitive styles. For example, whites tend to be field independent – working better alone, where as Mexican Americans are culturally field dependent and work better in groups that are trying to accomplish a common goal (Creason, 1992).

A recent study by Sayles (2004) advocates use of his Leading Diversity Process Model that uses aspects of engineering problem solving to tackle the problem of increasing diversity of students and faculty in science and engineering.

Issues for Transfer Students

Community colleges with open enrollment have a student body that is generally older, commuters, nonresident, part-time, nonwhite and working class. Two-year institutions comprise 28 percent of all U.S. colleges and universities and are the fastest growing sectors in the post-secondary system. Four year institutions tend to have selective enrollment and students who are residential, non-minority and of middle or upper middle-class social origins (Pascarella, 1999).

Research indicates that there are disparities in the perception of the quality of education students receive at community college versus four-year institutions, and that many student experience academic, social, and climate adjustments during the transition from a two to a four year campus (Pascarella, 1999). Almost half of all undergraduates and first time freshmen enrolled in higher education are at community colleges, with many indicating a desire to transfer to a four year institutions and obtain a baccalaureate degree. In Texas, this number is over 54% of students enrolling in four year institutions with community college transfer credits (Texas Higher Education Coordinating Board, 2004a). This large pool of students at community colleges, suggests the need to review transfer student experience and the potentially complex adjustment process academically, socially and psychologically attributed to the environmental differences between two and four year campuses (Eggleston & Laanan, 2001; Laanan, 2001; Rhine, Milligan, & Nelson, 2000). Students who are well informed and actively prepared for transfer are most likely to have higher academic performance and be more satisfied with university experience (Berger & Malaney, 2003).

Across the U.S., financial resources for state higher education are diminishing with little expectation of increases in resources to accommodate the expected increase in additional students desiring access and services from institutions of higher education. Often larger four-year institutions are looking at community colleges to fill the gap as a mechanism to stretch available dollars. The rising cost of higher education has also driven many students to seek alternate routes to a degree that are more cost-effective (Cheslock, 2003). These issues have contributed to enrollment increases at community colleges nationwide with two-year or community colleges now providing not only the means to an Associate degree but where a significant number of low-income, first-generation, and underserved students enroll prior to transferring to a four year institution for baccalaureate degrees.

The cost of tuition at a community college averages 60% of the cost at a four-year institution. One out of four community college students indicate that they intended to transfer to a four year institution, with 65% of those transferring doing so without an associate's degree (Laanan, 2001). In 2002, minority student enrollment was 33% of the national community college student body, 25% at four-year campuses, and 28% at all institutions, with community college enrollment growing at a faster rate than that of four-year institutions (Boulard, 2003).

Issues of educational quality and diversity will become even more significant to higher education as minority students, particularly Latinos, increasingly begin their college experiences at community colleges and fail to progress to four-year institutions (Harrell & Forney, 2003; Suarez, 2003). Community Colleges enroll over 50% of Hispanic students in higher education, yet the educational pipeline is one of leaks with an estimated 12% transfer rate for Hispanics and African Americans, compared to 22% nationally, 23% for White, and 23.6% for Asian students (Suarez, 2003).

In Texas, 85% of students transferring from two-year to four-year institutions enroll for a second semester at the four-year institution. A recent dissertation indicates that the number of students transferring has increased, as has the rate of transfer (Bush, 2002). Lower-division institutions, including community colleges, accounted for the majority of growth in student enrollment for Texas, totaling 536,005 in 2003, up 20,234 students from fall 2002 (Texas Higher Education Coordinating Board, 2004b). Additionally, 2001 enrollment (all ages) for Texas public universities had 61 % white, 22% Hispanic, and 11% African American, compared to two year institutions of 54% white, 30% Hispanic and 11% African American, indicating the greatest participation by Hispanics is at the community college or two-year institution, a fact of significance to the quest for diversity by Texas institutions of higher education (Texas Higher Education Coordinating Board, 2003).

In the U.S., up to 48% of transfer students among first time entering students are racial or ethnic minorities, with studies indicating specific issues to Hispanics, including cultural and economic considerations, that hinder degree attainment at four year institutions, (Eggleston & Laanan, 2001; Olivas, 1986). While many factors affect the Hispanic students' success and persistence toward a degree, the initial attendance at a community college clearly adds a layer of complication in obtaining a baccalaureate degree as it necessitates a transfer process to a four-year institution.

The low socio-economic status (SES) of most Hispanic students and their predominant first-generation student status negatively impacts their attendance and persistence in college. While minority students are least likely to have relatives with knowledge on how to assist with the higher education and transfer experiences, they are also the least likely to seek faculty outside of class. One study indicates that 77% of Hispanic and white students seldom or never saw faculty outside of class, and students did not take advantage of opportunities, such as workshops or academic and career counseling, that enhanced academic or social integration that other studies have indicated assist greatly with student persistence and academic performance (Nora & Rendon, 1990).

Furthermore, the need to work and commitment to family discourages the institutional affiliation that studies such as the seminal works of Astin, Pascarella, and Tinto indicate is critical to the retention and persistence of students. Several studies have indicated ethnicity did not impact a student's predisposition to transfer (Gao et al., 2002; Nora & Rendon, 1990).

The study by Nora and Rendon (1990) shows that the combination of student background factors and interactions with the community college environment determine academic success of failure of Hispanics. Their study also shows that ethnic origin did not significantly impact a student's predisposition to transfer, with results indicating that four other factors had significant impact on student's predisposition to transfer: 1) academic integration, 2) social integration, 3) initial commitments (to transfer), and 4) parents' educational attainment.

A 2002 study (Gao et al., 2002) indicates that the number of hours a student transfers to a four year institution and first term academic performance make a difference in graduation and retention rates. The study's structural equation models indicate transfer credit hours have strong effect on student graduation and retention as did student academic performance in community college coursework. Students transferring 32 or more credit hours graduate at a higher rate than native students (first time attending freshmen). Ethnicity, sex, and age have no effect on graduation or retention (Gao et al., 2002).

Research has defined that grade points generally fall or dip for students transferring from a two to four year institution (Eggleston & Laanan, 2001). Termed *transfer shock*, often a student experiences a .3 to .5 decline in the first semester GPA. However, the majority of studies show that 34%, or approximately 1/3 of transfer students recovered from transfer shock completely with the other 2/3 having partial to complete recovery (Laanan, 2001; Rhine et al., 2000). Students report a reduction in transfer shock when collaboration between two- and four-year faculty took place.

Complicating transfer shock is the applicability and acceptance of transfer credits toward a degree program, with graduation potentially being delayed by one or more semesters due to a student transferring in without one or more lower-level prerequisite courses (Rhine et al., 2000).

Due to conflicting reports of native students outperforming transfer students or there being no difference in performance between the two groups, Porter (2002) conducted a study that found transfer students do not perform as well as native students after statistically adjusting for transition points and transfer credit hours. His method compares new transfers with returning natives, since both have already experienced the initial first-year college transition issues and are at the same or similar points in their academic careers. The study controls for what Porter considers the most important variable: number of credits earned. Results include lower retention and graduation rates, along with lower cumulative grade point averages, and higher academic dismissals for transfer versus native students (Porter, 2002).

A course-based study to further detail transfer shock indicates that the academic preparation and performance of community college students in advanced mathematics and chemistry courses (math and science) should be reviewed by academic advisors at four-year institutions. The study finds that courses described by Hanson (1998) as "formidable gates" or gate-keeping courses were the most difficult for all students but often impacted transfer students to an even greater degree than native students, those enrolling as first-time students at the four-year institution (Hanson, 1998; Hoyt, 1999).

Issues for College Students with Financial Needs

The cost of higher education has been outpacing the Consumer Price Index for more than a decade (Yost & Tucker, 1995). A 2003 congressional report documents that over the 10 year period ending 2001-2002, after adjusting for inflation, tuitions and fees at four-year institutions, both public and private, rose 38%. In the 1980s, college costs rose three times faster in the 1980s than median family income. Even though within that time period federal student aid increased by 161%, more than 70% of high school student's parents surveyed now think that higher education is being priced "beyond the income of the average family" compared to 44% feeling housing costs are out of reach. Pell Grant funding has increased to an all-time high under President George W. Bush by 2004, but tuition increases across the U.S. have regularly been three to four times (and sometime more than) the rate of inflation (Boehner & McKeon, 2003).

For the first time in a decade, proposed changes to the federal formula for Pell Grants in 2005 are estimated to reduce the eligibility for financial aid of approximately 1.3 million students. This change is designed to lower the increasing pressures on Congress to reduce the $4 billion shortfall in the Pell programs budget and should ultimately benefit the neediest students. This effort was in lieu of the request by many in higher education and financial aid to increase the maximum grant amount of $4,050, something Congress seems unwilling to do until the program's deficit is eliminated. Projections are that although students may not drop, they will have to borrow more money, work more hours, or reduce course loads. The greatest impact may yet to be seen as changes to the federal formula trickle down as many states and institutions of higher education use the federal formula when awarding need-based aid. It is anticipated that approximately 90,000 students could become ineligible for Pell grants or other financial aid in fall 2005 when the new formula goes into effect (Burd, 2005).

In a state by state analysis over ten year period ending 2001-2002, Texas has seen tuition increase at two-year institutions by 9% and four year institutions by 20% with per capita income increasing by only 1% (Boehner & McKeon, 2003). The erosion in the amount of college costs covered by Pell Grants has resulted in work-study and loans taking on a larger and larger portion of a student's financial aid package. Many of the state budgets are constrained such that they are unable to provide the increased funding needed for public institutions of higher education. All this has served to further disadvantage the poor and most often the minority student in securing a college education or place them in a substantial amount of debt upon graduation (Ficklen & Stone, 2002).

Fifty percent of the 2001 enrolling freshmen borrowed for college (Gladieux & Perna, 2005) and grew to 65% by 2003 (Choy, Li, & Carroll, 2005), with a continuation of this trend is expected as more students anticipate the need to work and take out debt to attend college in the future (The Higher Education Research Institute, 2005).

Even though studies indicate that loans to pay for a higher education still offer a tremendous return on earning power over the life of a college graduate as compared to a high school graduate (Texas Guaranteed Student Loan Corporation, 2004), predictions indicate that continued increases in college costs will create wide income-related gaps and lack of college participation and degree completion in the future (Ficklen & Stone, 2002). This is of particular concern related to the minority student who will be a significant percentage if not majority of college age population in the near future (Campbell, 1997; Georges, 1999).

Financial aid now plays a major role in an undergraduate student's ability to obtain a college education. One third of all undergraduates in the U.S. were enrolled in public four-year institutions like TAMU, and more than half (55%) of those 1999-2000 undergraduates were receiving some form of financial aid, while 52 % had borrowed from Federal student loan programs at some point in their academic career. The average financial aid amount per student was $6,400, with 96% of all undergraduate borrowing in 1999-2000 done via the Stafford Loan program. This increase in the need for financial aid and loans is directly linked to the developments in the 1980s of rising tuition and cost of living that caused many students to increase student loans and work to assist with the cost of college (U.S. Department of Education, 2002b).

An issue raised in the literature on retention is the impact that financial need has on student retention and performance, especially since minority populations are often financially disadvantaged. Being from low-income families, borrowing, and working while in school place a student at greater risk of not completing a degree (Georges, 1999; National Science Foundation, 2003; U. S. Department of Education, 2002b).

Part-time attendance and working more than 15 hours per week reduces the persistence of students toward completing a degree, while borrowing also increases a student's likelihood of persisting (Choy, 2002). There is also evidence that time to completion as well as completion of a degree vary with the income levels of a student's family. Brown (1996) attributes high attrition and lower enrollment for minority students to greater poverty among students of color and alterations that have occurred in financial aid packages. African American undergraduates are the most likely to receive financial aid at 69% followed by Hispanics at 58.3% (U. S. Department of Education, 2002b).

Bresciani and Carson (2002) expanded on research findings that financial aid is a factor in student persistence and performance to focus on percentages of gift aid, loans, and unmet financial need. Their topic of study builds on research indicating that various financial variables contribute more to the variability in student persistence than did those related to social or academic integration of students. Their findings indicate that the level of unmet financial need is more a predicator of student persistence than is percentage of gift aid, with students having unmet need greater than 25% yet receiving gift aid persisting at a lower rate than those with no aid.

Student values also appear to have changed during the thirty years, with being "very well off financially" now a goal of 80% of entering college freshmen, while the value placed on developing a meaningful philosophy of life dropped from the top place in 1960 to sixth place in the 1990s (Astin, 1998). This supports Pister's study (1993) on student constraints and diversity due to demographics that indicates "from the student's perspective, time to an engineering degree and its associated costs are primary constraints…Institutional requirements for the baccalaureate degree are likewise a factor". Heckle's (1996) study of thirty years of engineering enrollment and graduation data indicates that engineering enrollment correlated to high school (enrolling) and undergraduate (graduating) student views of increased economic gain rather than national economic trends (Heckel, 1996); thereby supporting the view that economic factors have influence on a student's choice of major.

History of Engineering Education

The concentration in the curriculum on more engineering science has it roots in the post World War II era. The late 1800's and early 1900's found engineering colleges emphasizing heavily technical applications such as surveying, apprenticeships and coursework like machine shop, very much like the technical schools of today. After World War II, the Federal government began to heavily fund scientific research at universities, creating new possibilities for an academic engineering researcher. This focus drove the efforts of faculty toward establishing "engineering science" as the foundation of "engineering education". Replacing the drafting and surveying courses of the pre -WW II era were courses in fundamental sciences, mathematics and engineering science, all of which sprang from the German model of European research universities (Grayson, 1993). Individuals educated in Europe brought to the U.S. the belief that mathematics and science were necessary problem solving tools. The 1955 Grinter Report recommended that more science be taught in engineering schools. This set the precedent and foundation for what the engineering curriculum would become up until the 1990's (Grinter, 1955).

By the late 1950s, engineering schools seeking to grow and attract federal research funding focused on developing graduate schools to support fundamental research programs and emphasize engineering science (Seely, 1999). Basic science and mathematics became the predominant curricula in the fifties and sixties, replacing engineering components, the result of a belief that engineering is primarily applied mathematics and science. Hence, there is a need to study and master those concepts first (Harris et al., 1994). Today there is a movement to put design back in the lower division curricula, in order to show the relationship between basic science and mathematics to engineering applications. A number of institutions have created foundational courses "based on the premise that there exists a central body of knowledge, methods and attitudes which constitute what one might call the "Art" of Engineering" (Quinn, 1994).

The 1980s and 1990s saw a movement to reform engineering education from the more traditional engineering science to one that better educated the student for careers in industry. An effort was made to integrate engineering applications with those from mathematics and science coursework (Al-Holou et al., 1999; Bjorklund & Colbeck, 2001; National Research Council Center for Science, 1985; National Research Council, 1986, 2003; National Science Board, 1986; Panitz, 1997; Pister, 1993). Industry, often a critical partner and financial contributor to colleges of engineering around the nation, began clamoring for a problem solving engineering graduate, who was also able to work in teams and communicate effectively (McGraw, 1999). This more broadly educated engineer was essential to industry if the US hoped to maintain its position as a world economic power. As a result, a number of nationally based scientific agencies commissioned studies on the engineering and science workforce (Bucciarelli & Kuhn, 1997; Clough & Kauffman, 1999; McGraw, 1999; National Science Foundation, 1989, 1996, 1998; Prados, 1998). Prior to these changes most engineering students spent much of their first and second years learning mathematical and science theory. More specific engineering applications such as design did not appear until perhaps junior level courses.

Significant studies and reports in the 1980s saw a wave of reform reach many engineering colleges. The 1987 American Society for Engineering Educators report "A National Action Agenda for Engineering Education", acknowledged the need for reformatting the engineering curriculum because of rapidly changing technologies. The report also recognized the need for a modern system of preparing engineering students for the life-long learning process essential for success in the field, and encouraged the formulation of the engineering sciences into a coherent body of knowledge, as well as the infusion of design applications into the curriculum. ASEE also advocated a strong emphasis on recruiting women and underrepresented minority students into engineering, since the then traditional pool of white male undergraduate students was not expected to increase (American Society for Engineering Education, 1987).

A variety of reports issued by taskforces (primarily the National Research Council, the National Science Foundation, and the American Society for Engineering Education) supported the ASEE study, confirming the need to reform undergraduate science, mathematics, and engineering education (American Society for Engineering Education, 1987; Association of American Colleges, 1985; National Research Council, 1986; National Research Council Center for Science, 1985; National Research Council, 1986; National Science Board, 1986; National Science Foundation, 1989). All of these reports stressed that in order to regain or maintain economic competitiveness and technological advances, the United States would have to recruit and retain more engineering students.

Recommendations were that critical thinking skills be derived from a foundation in and deep understanding of the integration of the physical, life and mathematical sciences as well as the humanities and social sciences. The reports call for critical analysis and reformatting the first two years of engineering curriculum, and stress the need to incorporate the practical aspects of design and topical integration into this part of the engineering curriculum (National Science Foundation, 1989).

The Green Report (ASEE, 1994) continues to use the term "life-long learning", seen in the above mentioned task force reports. It also refers to a universal "core" curriculum of engineering fundamentals, and stresses the link between engineering education and global competitiveness, particularly related to information technology. The rapid change occurring in technologies, such as information technology, requires for engineering graduates who are self-learners, and who have life-long learning skills.

The more than 300 colleges of engineering have common minimum standards and a universal core curriculum through the accreditation process provided by the Accreditation Board for Engineering and Technology (ABET). Many forge strong relationships with industry, which the reports suggests should be expanded so that colleges become more context based with relevant to constituents (Brainard, 1999). The ASEE report (1994) advocates a continuation of teaching the fundamentals of engineering theory, experimentation and practice, but additionally reforming engineering education in order to be consistent with national needs. It also notes the need for new approaches and a rethinking of traditional curricula and teaching methods in order to improve the recruitment and retention of students, particularly in attracting and retaining students from underrepresented groups. Proposed engineering programs should be more relevant and cost effective for all students, more attractive to groups historically underrepresented in the field of engineering, and remain “connected” to industry and government to ensure that industry’s needs are being met (American Society for Engineering Education, 1994).

Recent Trends in Engineering Education

As the historical perspective indicates, the 1990’s witnessed reform efforts in engineering education. These reforms focus on integrated curriculum and mechanisms to increase student learning and problem solving abilities in the belief that students would be retained in greater numbers (American Society for Engineering Education, 1987, 1994; National Science Foundation, 1996; Panitz, 1997; Seymour & Hewitt, 1997). The theory underlying curriculum integration was that it would assist students with developing connections to topics or concepts throughout the curriculum and that team mechanisms for collaborative learning and practical applications. The end results would be an enhanced understanding by students of how these applications would be used in their industrial careers (Clough & Kauffman, 1999).

The Accreditation Board for Engineering and Technology (ABET) Criteria 2000 (Accreditation Board for Engineering and Technology, 2004) focuses on the infusion of design components as early as the freshmen year. An engineering student’s first year curriculum is still predominately composed of chemistry, physics and mathematics

(Calculus) courses. However, engineering colleges are responding to ABET and other research by introducing courses on design as early as the first year. By their sophomore year, students are normally involved in engineering-based coursework with applications.

Institutions are also making efforts to incorporate pedagogical research as industry continued to emphasize to engineering educators the need for graduates with communication and teambuilding skills and the ability to problem solve and learn new things throughout the span of their careers, again using the term *life-long learner* (Gabelnick et al., 1990; Pister, 1993; Quinn, 1994). Many of these efforts are being investigated by colleges of engineering throughout the country to meet the desires of industry, to align with the "new" accreditation format of ABET (Accreditation Board for Engineering and Technology, 2004), and later to secure funding from federal agencies such as the National Science Foundation where education and educational reform have are major components associated with solicitation of grants.

Researchers indicate that if there is to be true educational change, then the way faculty teach must be reformed along with the structure of the support and reward mechanisms for development of faculty teaching skills (Clough & Kauffman, 1999; Felder, Stice, & Rugarcia, 2000b; Pister, 1993; Tobias, 1990). "Educational Scholarship" places a focus on effective teaching in engineering and faculty professional development that enable faculty to gain the tools to become better teachers, thus creating a positive campus climate for student learning (Felder et al., 2000; National Research Council, 1999). Much of this is instigated by the changes in accreditation requirements of ABET 2000 and its shift in focus from a checklist of course content to establishing desired outcomes of student learning (Accreditation Board for Engineering and Technology, 2004). However, the continued focus on research at most institutions has had the effect of devaluing teaching and having teaching and student learning take a back seat to the acquisition of funding and the conduct of research. (Felder et al., 2000a).

A recent change nationally is the significant shift in focus from teaching to student learning. This is happening in large part due to interdisciplinary application of the research on cognitive development being coupled with educational methodology and mechanisms. Leaders in this work at Vanderbilt University define four characteristics of effective learning environments: learner-centered, knowledge-centered, assessment-centered, and community-centered (Bransford, Brown, & Cocking, 2000). These tie strongly to the reform efforts in engineering education advocated and implemented in the 1980's and 1990's (American Society for Engineering Education, 1994; Gabelnick et al., 1990; National Research Council Center for Science, 1985; National Research Council, 1986; Olds & Miller, 2004; Pister, 1993; Treisman, 1992).

A ten year study by Bjorklund and Colbeck (2001) defines changes in engineering education through 27 interviews with engineering educators and industry employers. Interviewees were asked: "What were the two most significant changes in the field of engineering education and in the way undergraduate engineering students are prepared?" The top five changes identified were: "1) the incorporation of design throughout the curricula; 2) an emphasis on effective teaching; 3) the influx of computer technology in the classroom and beyond; 4) the need for a more broad-based curricula;

and 5) a new interest in assessment (student) due in large part of ABET 2000 accreditation criteria".

Internationally, activities are taking place to create curriculum changes to better serve the multitude of stakeholders desiring a quality engineering graduate. Advocating that the traditional core curriculum address the preparing of professional engineers, research identified needs for change and process by which such change could be sustained and institutionalized. Walkington's (2002) overview for creating systemic change in engineering education, advocates a process, that though lengthy and time consuming, promises to establish faculty buy in that will sustain changes proposed by curriculum reform committees.

TAMU Engineering Education

The Dwight Look College of Engineering at TAMU is among a number of institutions that focuses on engineering education reform in the 1990s. Through programmatic funding by agencies such as the National Science Foundation (NSF), TAMU along with other institutions, such as Dartmouth, found that grouping, or "clustering" students, integrating curriculums, and using teamwork and active and cooperative learning methodology in the classroom led to increases in student performance and retention (Felder et al., 1993; Olds & Miller, 2004; Pndergrass et al., 2001; Seymour, 1999, 2001; Woods et al., 2000). This is being accomplished through teaching innovations and the integration of introductory sequences in science, math and engineering courses. The College uses classroom teaching improvements and an integrated curriculum requiring a **Common Body of Knowledge** (CBK) sequence for first-year entering students.

In 1998, the College formalized the CBK coursework series required of all first-year students. CBK is defined as the required engineering lower level courses of General Chemistry for Engineering Students (CHEM 107), Composition and Rhetoric (ENGL 104), Foundations of Engineering I & II (ENGR 111 and 112), Engineering Mathematics I & II (MATH 151 and 152), and Physics (PHYS 218) or equivalent at TAMU (Texas A&M University, 1998). Computer Science and Engineering Technology majors in the College take a different series of coursework than main engineering majors. This study focuses on five majors that are common to most if not all peer colleges of engineering around the country: The 1998 and 1999 TAMU Undergraduate catalog lists the following requirements (Texas A&M University, 1998, 1999).

> Students who meet the University entrance requirements enter the College of Engineering with lower-level classification. Enrollment in sophomore, junior and senior level engineering courses will be restricted to those students who have been moved from lower level to a major degree sequence within the College of Engineering. For most majors, grades of "C" or better are required in the Common Body of Knowledge (CBK) courses. .... To be considered for admission to a major degree sequence a student must be in good academic standing and have received credit for specific courses…. students seeking admission to a major degree sequence in engineering must have credit for CHEM 107, ENGL104, ENGR 111,112, MATH 151 and 152, and PHYS 218 or equivalent.
>
> Students will be allowed to remain as a lower-level student up to 60 hours (provided they are in good standing and making progress). At the 60-hour limit, students will be blocked from further registration in that department if the CBK and overall GPR requirements for upper division have not been achieved (Texas A&M University, 1998).

However, the number of semesters necessary to achieve the required CBK and overall grade point average is currently not considered.

Advancing to upper level status requires students to 1) obtain a grade of “C” or better in each of the CBK courses, and 2) have the cumulative grade point average required by the department of the student’s major. Currently, there is not a time limitation or requirement for completing the CBK coursework and advancing to upper level status in an engineering department. This was often incorporated into the framework of first and second year courses that contained the “common body of knowledge” deemed necessary for engineering student success in upper level coursework. Each department within the College sets the overall grade point average for entry to upper level status after completion of the required CBK.

CHAPTER III

METHODOLOGY

Purpose of the Study

The purpose of this study is to determine for first year engineering students at TAMU the relationship of the gender, ethnicity, cumulative grade point average, engineering major, unmet financial need, and total transfer hours on time to completion of CBK courses.

Research Questions

The following questions were proposed for the study:

The study will seek to answer the following questions:

7. What is the relationship between gender and time to completion of CBK?
8. What is the relationship between ethnicity and time to completion of CBK?
9. What is the relationship between student unmet financial need and time to completion of CBK?
10. What is the relationship between student major and time to completion of CBK?
11. What is the relationship between cumulative grade point average at time of progression to upper level status and time to completion of CBK?
12. What is the relationship between the total number of credit hours transferred at time of enrollment at TAMU in engineering and time to completion of CBK?

Population

The subjects for this study will be first-year first time enrolling students in the Dwight Look College of Engineering (College) at Texas A&M University for the cohort years 1998 and 1999 majoring in Chemical, Civil, Computer, Electrical, and Mechanical engineering. These five departments have the majority of first time enrolling students in the College. With regard to the required GPR for movement to upper level status, the five comprise a spread of GPR from 2.50 to 3.125 on 4.0 scale. The 1998 and 1999 populations for first-year entering engineering students total 2,657 - 1,494 for 1998 and 1,163 for 1999 (Engineering Academic Programs, 1998, 1999).

Procedures

The data set was obtained through the Engineering Program Academic Office of the Dwight Look College of Engineering at Texas A&M University. Data are collected and maintained through the College for analysis and for evaluation and assessment activities of several National Science Foundation grants on which the College participates. Data exclusive of identifier or codes were obtained in spreadsheet format by the researcher for first-year first time enrolling engineering majors in cohort years 1998 and 1999 and contained 2,657 students.

The population for this study is defined as first time enrolling students from 1998 and 1999 in five targeted majors: Chemical, Civil, Computer, Electrical, and Mechanical engineering in the College of engineering. The five majors selected for this study are those majors found in most engineering schools nationally. Not included in the population are the 512 students having other majors. Since the dependent variable is defined as time to completion of CBK, or progression to upper division status, the 888 students that did not complete a semester in these targeted majors are not included in the population.

After eliminating these 1,400 students who entered in 1998 and 1999 as engineering majors from the population, 71 students were eliminated for missing data. This was determined to be a representative group by the Engineering Academic Program Office and appropriate for drawing conclusions about the impact of the independent variables on time to completion for students in these majors.

Thus, from the original data set of 2,657 records, 1,492 were excluded as follows:

- 526 students were in other majors other than the five targeted majors related to study
- 905 students not progressing to upper division (completing CBK) in on of five targeted majors
- 61 students with missing data related to variables needed for analysis

This left a population of 1,165 student records with complete information that were used for this study.

Due to the impact of credits that were transferred into TAMU by the student, data were obtained on the number of transfer credits students considered first-time entering in 1998 or 1999. This data allowed for two groups to be established: 1) students having no transfer credits when entering and 2) students entering with transfer credit.

Data Analysis

SPSS Advanced Statistics© (Version 11) package was utilized to determine overall frequencies and means for the five targeted majors (Civil, Chemical, Electrical, Mechanical, and Computer Engineering). The dependent variable is the time to complete CBK courses. Independent variables will be:

1. Gender
2. Ethnicity
3. Cumulative GPA
4. Engineering Major
5. Unmet Financial Need
6. Total Transfer Hours

Independent variables one, two, four, five are non-continuous or nominally-scaled. Gender and Unmet Financial Need are true dichotomous variables, while Ethnicity and Engineering Major variables required dummy coding to be used in the regression analysis (Ibrahim et al., 1999). The variable for gender was coded 0 = male and 1 = female. The variable for Unmet Financial Need was created where 1= yes and 0= no.

When creating dummy variables for *n* groups, one must create n-1 variables (Mendenhall & Sincich, 2003). Variables for ethnicity were created in two ways. First, a true dichotomous variable was created of 0 = not underrepresented minority (White and Asian) and 1 = minority (African American, Hispanic, and Native American). Then, dummy variables were created. Since a dummy variable has to be dichotomous and three groups were in ethnicity (1. African American; 2. Hispanic; 3. White, Asian and other) it was necessary to create two dummy variables. African American yes = 1 no =0 and Hispanic yes =1 and no=0; white and other were coding in zero since not underrepresented minority. Although this present study is examining relationships and does not develop a predictor model, Table 2 indicates how these variables would be represented if used in a regression equation for prediction.

Table 2
Mean Response for the Model with Three Ethnic Groups

Ethnicity	x_1	x_2	Mean Response, E(y)
White, Asian, Other (O)	0	0	$B_0 = \mu_O$
African American (A)	1	0	$B_0 + B_1 = \mu_A$
Hispanic (H)	0	1	$B_0 + B_2 = \mu_H$

There were five majors targeted for this study, which would be five levels of major as indicated in Table 3 below. Civil engineering was chosen as it had the least number of students of all five majors.

Table 3
Mean Response for the Model with Five Majors

Ethnicity	x_1	x_2	x_3	x_4	Mean Response, E(y)
Civil (CE)	0	0			$B_0 = \mu_O$
Computer Engineering (Cm)	1	0	0	0	$B_0 + B_1 = \mu_{cm}$
Electrical Engineering(EE)	0	1	0	0	$B_0 + B_2 = \mu_{EE}$
Chemical Engineering (ChE)	0	0	1	0	$B_0 + B_3 = \mu_{ChE}$
Mechanical Engineering (ME)	0	0	0	1	$B_0 + B_4 = \mu_{ME}$

Effect size of R^2 and adjusted R^2 and beta weights are reported. P values are also reported with an alpha of .05 throughout the data analysis. Based on the review of the literature in addition to main effects described above, this study will also examine interaction effects for three variables: gender, underrepresented minority status, and unmet financial need.

CHAPTER IV

ANALYSIS AND INTERPRETATION OF THE DATA

Introduction

The purpose of this study was to determine for first-year engineering students at TAMU the relationship of gender, ethnicity, cumulative grade point average, engineering major, unmet financial need, and total transfer hours to time to completion of Core Body of Knowledge (CBK) courses. This chapter presents the descriptive parameters, t-tests, and analysis of variance results in figures and tables. Findings are discussed as they relate to each of the research questions posed for the study.

Population

The cohorts of first time enrolling engineering students from 1998 and 1999 were chosen since 1998 was the first year that CBK was required of all majors in the College of Engineering at Texas A&M University and the addition of students from 1999 would allow for a large enough population for the study after the anticipated need for elimination of faulty or missing data. Data was obtained from the Engineering Academic Program Office (EAPO) initially and later transfer information on total transfer hours was obtained from the TAMU Student Information Management System (SIMS). Table 4 indicates the number of student records obtained and the number used for this study.

The initial 1998 and 1999 data set obtained from EAPO contained 2,657 students. The list of students was narrowed to only those in the five majors targeted by this study. These included Chemical, Civil, Computer, Electrical, and Mechanical engineering. These five majors were selected since they are offered by a majority of colleges of engineering in the U.S.. There are approximately 345 colleges of engineering in the U.S. of which the following offer degrees in the five targeted majors: 153 in Computer Engineering, 154 in Chemical Engineering, 217 in Civil Engineering, 254 in Electrical Engineering, and 268 in Mechanical Engineering (Gibbons, 2005). Further, of the 30 universities that TAMU College of Engineering considers peer institutions, 26 colleges offer majors in all five majors with the remaining colleges of engineering offering four of the five majors targeted by this study (American Society for Engineering Education, 2005; Engineering Academic Programs, 2005).

Table 4
Population of the Study by Cohort Year

Cohort	**# Entering**	**# Not major of Interest**	**# not progressing**	**# w/ missing data**	**Number Used**
1998	1494	299	479	42	674
1999	1163	227	426	19	491
Total	2657	526	905	61	1165

There were 526 TAMU engineering students with majors other than the five targeted. These 526 students were eliminated from the study. An additional 905 students whose data indicated they did not progress to upper division status in the targeted majors were also eliminated. Therefore, 1,400 (512+888) records were eliminated due to students not enrolling or progressing to upper division status as one of the five targeted majors. This left 1,257 student records remaining.

These 1,257 student records were reviewed for missing data and 61 student records were eliminated from the data set due to missing data related to the categories unknown or other ethnicity, number of semester hours to progression, unmet financial need status or cumulative grade point average (CGPA). The remaining 1,165 student records became the data set used for analysis in this study.

The list of 1,165 students was given to SIMS with a request for information related to total transfer hours accepted by TAMU for each student. Student data was coded to avoid possible identification of individual students. The transfer information received was merged with the adjusted data set of 1,165 students that had been refined to eliminate missing data, majors other than those five targeted in the study, and those not completing CBK. This refined data set containing information on 1,165 first time enrolling engineering students at TAMU was used for the descriptive parameters and statistical analysis of this study. Statistical analysis and results were detailed by major as a starting place for future analysis and study at the departmental level. Because this is a population study and a sample was not drawn, all analyses are of parameters, not statistics.

Descriptive Parameters

Nationally and in the College of Engineering (College) at TAMU, ethnicity and gender are of critical importance regarding enrollment of students. Table 5 indicates the ethnicity and gender of the students in this study.

There were 960 (82.4%) male and 205 (17.6%) female students in the study. African Americans comprised 2.6% of the population; Hispanics 7.2%; Asian 6.6%, Native American 0.01% and Whites 83.4%.

Table 5
Ethnicity and Gender of Population

	Male (N= 960)		**Female** (N= 205)		**Total** (N= 1165)	
	N	%	N	%	N	%
African Am.	13	1.12	17	1.46	30	2.60
Hispanic	69	5.92	15	1.30	84	7.20
White	819	70.30	153	13.13	972	83.40
Asian	59	5.06	18	1.55	77	6.60
Other (Native Am)	2	<0.01	0		2	<0.01
Total	960	82.40	205	17.60	1165	100

There were a greater number of African American females than African American males in the study population (17 females, 13 males), and a much larger number of Hispanic males than Hispanic females (69 males, 15 females). The study's African American population was the only ethnic group where females outnumbered males, though these numbers were not large. White males in this study outnumbered White females by almost five times (819 males, 153 females). White females were the largest ethnic group in the study's female population. There were 59 Asian males compared to 18 Asian females, and the Native American numbers were miniscule compared to any other ethnic group at less than .01% of the entire population with all of the Native American students being male.

Of the 1165 students, ethnicity for this study with applicable percentages of the total population included 77 Asian students (6.6% of the total population), 30 African

American students (2.6%), 84 Hispanic students (7.2%), 2 Native Americans students (0.2%), and 972 White students (83.4%). Demographic data for this study of first time enrolling students indicates they are predominantly White and male, which aligns with national first-year undergraduate engineering enrollment data for 1998 and 1999.

In 1998, national enrollment percentages for first-time engineering undergraduates were: 80.4% male, 19.6% female; 69.1% White, 10% Asian, 8.5% Black, 7.4% Hispanic, and 0.8% Native American. In 1999, enrollment percentages were: 80.8% male, 19.2% female; 68.6% White, 10.2% Asian, 8.5% Black, 7.5% Hispanic, and 0.7% Native American (National Science Foundation, 2002).

Demographic characteristics of the population are further broken down by major in Table 6.

Table 6
Ethnicity and Gender by Major for Population

	Computer Engineering	Electrical Engineering	Chemical Engineering	Mechanical Engineering	Civil Engineering
African Am.	13	6	4	4	3
Female	2	3	1	1	1
Male	11	3	3	3	2
Hispanic	21	8	12	31	12
Female	4	1	6	4	2
Male	17	7	6	27	10
White	183	173	178	316	121
Female	17	24	56	37	20
Male	166	149	122	281	101
Asian	34	15	19	8	1
Female	3	3	11	1	0
Male	31	12	8	7	1
Native Am	0	1	0	0	1
Female	0	0	0	0	0
Male	0	0	0	0	1
Total	**251**	**203**	**213**	**361**	**137**

Excluding Native American, the only empty cell for ethnicity and gender by major is for Asian female Civil Engineering students. Of the 1165 student in this study, there were 251 Computer Engineering majors, 203 Electrical Engineering majors, 213 Chemical Engineering major, 361 Mechanical engineering majors and 137 Civil engineering majors.

With regard to ethnicity and gender by major, Chemical Engineering has the greatest number of female students, and Computer Engineering has the greatest number of ethnic minorities. Computer Engineering is 5.2% African American, 8.4% Hispanic, 72.9% White, and 13.5% Asian; 10.4% female and 89.6% male. Electrical Engineering is 3.0% African American, 3.9% Hispanic, 85.2% White, 7.4% Asian, and 0.5% Other/Native American; 15.3% female, 84.7% male. Chemical Engineering is 1.9% African American, 5.6% Hispanic, 83.6% White, and 8.9% Asian; 34.7% female and 65.3% male. Mechanical Engineering is 1.1% African American, 8.6% Hispanic, 87.5% White, and 2.2% Asian; 11.9% female and 88.1% male. Civil Engineering is 2.2% African American, 8.8% Hispanic, 88.3% White, 0.7% Asian, and 0.7% Other/Native American; 16.8% female and 83.2% male.

Statistical Analysis

The data were analyzed using SPSS 10.0 software. In this study, all tests of significance were two-tailed and non-directional since this research was exploratory and not, "based on theoretical consideration or previous research" (Huck, 2000). CBK completion is also termed progression to upper division status for engineering students in the SIMS data system, so the two terms are used inter-changeably in this study.

There were six research questions numbered RQ1 through RQ6. Three types of statistical analysis were used in this study: t-test, one-way ANOVAs, and product-moment correlation coefficient (Pearson's r). Mean (μ) and Standard Deviation (σ) interval data are presented for all six research questions. CGPA at time of completion of CBK and transfer hours are continuous variables, with the remaining variables in the study being dichotomous: gender, ethnicity, and unmet financial need, major.

An initial t-test was run for each of the first four research questions (RQ1-RQ4), including use of Levene's Test for Equality to find which category should be used for equal variance are assumed or equal variances are not assumed. In practice a t-test is typically used regardless of sample size. The assumptions when using t-tests are: 1) the scores (dependent variable) form an interval scale of measurement, and 2) that population scores are normally distributed. Conducting Levene's Test for Equality with the t-tests ensures the assumption of equal variance for ANOVA is not violated. Levene's test for Equality is used to test the second assumption that the scores are normally distributed and that variances of the mean for the population are equal (Mendenhall & Sincich, 2003). When the assumption of variances being equal was not met, a correction for equal variance not assumed was made and those results reported.

Each measured variable under comparison requires a separate t-test. Since this study did not hypothesize in advance of data collection, a two-tailed t-test is necessary

(Gall, Borg, & Gall, 1996). If results were statistically significant at the 0.05 level, then additional t-tests or ANOVAs were conducted to refine results.

Research Question 1 (RQ1) involves gender, and Research Question 3 (RQ3) unmet financial need. The variables of gender and unmet financial need are nominal scaled (Hinkle, Wiersma, & Jurs, 1998) as well as being true dichotomous variables (Gall et al., 1996) in that gender can only be male or female and unmet financial need is attributed to having (yes) or not having (no). For analysis these dichotomous variables are represented numerically in this study, where females = 1 and males = 0 and unmet financial need represented with 1 = having need and zero (0) as not having need.

Research Question 2 (RQ2) involves ethnicity, and Research Question 4 (RQ4) student major. The variables ethnicity and major are also nominally scaled, but not true dichotomous variable, in that there are more than two options for ethnicity and major. In order to conduct statistical analysis, the study had to create an artificial dichotomy by coding each ethnicity and major of interest as "dummy variables". This was accomplished by coding a variable as 1 for yes and all other not in that category as 0 (zero) for no. Further analysis took place by five data files by major being created and statistics conducted from each.

For RQ2, data were initially divided into true dichotomous variables of minority or non-minority status. Minorities are defined as those groups underrepresented in engineering: African American, Hispanic and Native American. Non-minority students were Asian or white, groups that are not considered underrepresented in engineering. Coding was 0 for non-minority and 1 for minority status. If results showed statistical significance, then further analysis was done. Dummy variables were created for each ethnic group. For instance in the case of African American and other, then 1 equals African American and 0 equal all those with ethnicity other than African American. In the event analysis was needed for one ethnic group, data sets were created for that ethnicity and statistical analysis conducted. In the case of African American by gender, a data file was established with just African American students with gender coded as 0 for males and 1 for females, or unmet financial need (UFN) coded 0 for not having UFN and 1 as having UFN.

RQ4 involves major, so 1 indicating that major and zero indicated not that major (a different major). An example would be 1 = Chemical Engineering and 0 = all other majors (Computer, Electrical, Mechanical, and Civil engineering). T-tests were run separately for each of the five majors in this study.

Pearson's Correlation was used for statistical analysis of RQ5 and RQ6. Gall (1996) indicates that Pearson Correlation, also known as product-moment correlation coefficient or Pearson r, is a "mathematical expression of the direction and magnitude of the relationship between two measures that yield continuous scores". This study used the product-moment correlation coefficient for these two questions since the data for both RQ5 (cumulative grade point average from zero to 4.0) and RQ6 (transfer hours) is continuous. Also known as Pearson r, it is the most widely used bivariate correlation because most education measures yield continuous scores and r has a small standard error (Gall et al., 1996).

This study also reports significance levels (p values) for each question in order to report "the likelihood that a statistical result was obtained by chance" (Gall et al., 1996). Correlations in this study are listed as significant at the 0.01 or 0.05 levels for a 2-tailed test. Hinkle (1998) defines the level of significance or alpha (α) level as "the probability of making a Type I error when testing a null hypothesis" (p. 193). Therefore a significance level of .01 indicates a 1% chance that an incorrect decision to reject the hypothesis may occur, or 99% chance of it not occurring and at the .05 significance level there is 5% chance of rejecting the null incorrectly. Anything not indicating significance was beyond the level of error accepted by this study.

Researchers usually have an interest in finding out to what degree each independent variable "contributes to" valid explanations. This study reports beta weights, which determine the contribution of the independent variable given that the other independent variables of the study are held constant (Mendenhall & Sincich, 2003). These factors stand alone and can be used in equations for further study and statistical analysis with predictor models. When beta weights were reported, N-1 dummy variables were used for ethnicity and major.

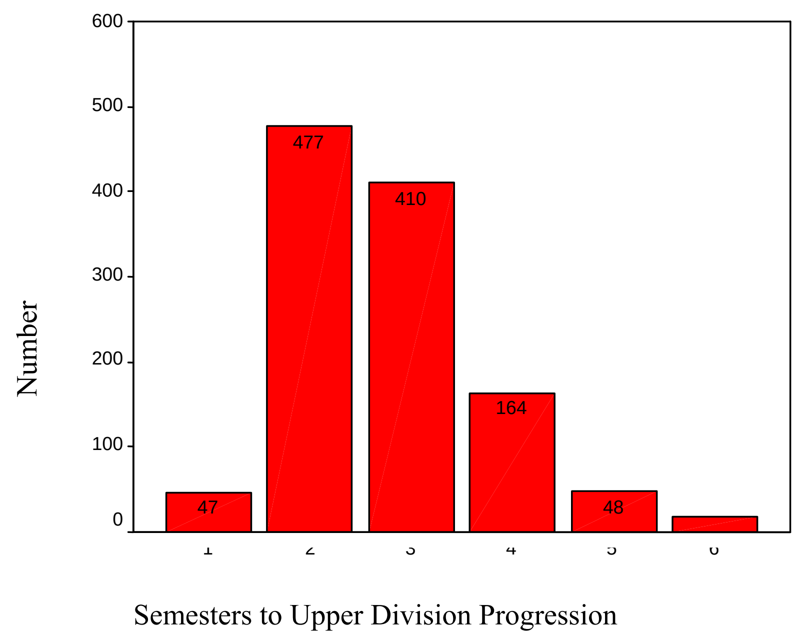
Effect size reported as R^2 and adjusted R^2 describes the proportion of the total variance that is accounted for by each independent variable or group of independent variables. Since effect size is reported as a squared term, it can also be reported as a percent of the total variance (Thompson, 1997). Cohen (1988) reluctantly defined effect sizes as "small, d = .2," "medium, d = .5," and "large, d = .8", stating that "there is a certain risk inherent in offering conventional operational definitions for those terms for use in power analysis in as diverse a field of inquiry as behavioral science" (p. 25).

Dependent Variable

Figure 2 indicates the number of semesters students in the study took to progress to Upper Division status by completing CBK with the required cumulative grade point average (CGPA). The largest number of students (887) or 76% completed CBK requirements and progressed to upper division status in either two or three semesters:

- 477 students took 2 semesters to complete CBK
- 410 students took 3 three semesters to complete CBK

Figure 2: Number of Students per Semester Progression to Upper Division Status by Completion of CBK



These results align with the degree plans of the five target TAMU Engineering majors in this study which allocate approximately three semesters for completion of CBK.

This study's effect size for all of the independent variables related to completion of CBK was a R^2 of 0.193 (19.3%) with an adjusted R^2 of 0.186 (18.6%), which is generally considered a small effect size. This indicates that other factors contribute approximately 80% to time to completion of CBK. The research literature (Chapter II) indicates these factors may include student motivation, academic preparation in high school, or other influences, including transitioning to a new social setting and cultural environment. Further study by the college may be warranted on these factors and is detailed in Chapter V.

Results and Analysis by Research Question

Question 1

1) What is the relationship between gender and time to completion of CBK?

In the United States, enrollment of full-time, first-year engineering undergraduates is 83% male 17% women (National Science Foundation, 2004). The percentages for TAMU students in the study align with the national averages for male and female first-year entering engineering students. Table 7 indicates the number and percent of male and female engineering students in this study.

Table 7
Gender of 1998-1999 Cohort TAMU
First-time Engineering Students

	Frequency	Percent
Male	960	82.4
Female	205	17.6
Total	1165	100.0

Gall, Borg, and Gall (1996) defines standard deviation (σ) as representative of how spread out data are for the various questions of this study and is a popular measure of variability. It is "a measure of the extent to which scores in a distribution deviate from their mean" (p, 178). One (σ) plus or minus of the mean in a normal distribution is representative of approximately 68% of the sample for a study, with two standard deviations (plus or minus of the mean) being representative of 95% of the sample.

Table 8 indicates average time to completion of CBK by gender. Female students are completing CBK faster (μ =2.61 semesters) than male (μ =2.82 semesters) engineering students. Male students had a σ = 1.00 and female students a σ = 0.94, indicating a slightly greater variance in time to completion by the male group.

Table 8
Descriptive Parameters by Gender

Gender	N	Mean	σ
Male	960	2.82	1.00
Female	205	2.61	.94

Levene's Test for Equality resulted in F = .035 and p = 0.852; therefore, since there was not significance, equal variances are assumed with results shown in Table 9.

Table 9
t-test for Gender

			95% Confidence Interval of the Difference	
	t	**Sig. (2-tailed)**	**Lower**	**Upper**
Equal variances assumed	2.68	.008*	5.43E-02	.35

*significance at .01 level

Significance was found at the .01 level (p = 0.008). Though this study does not create a predictor model, beta weights are report for potential use by researches in other future studies. The beta weight (β) for gender was -.038 with an effect size or R^2 of .006 and adjusted R^2 of 0.005.

Effect size indicates that, other variables held constant, gender contributes 0.6% (R^2 of 0.006) as a factor of time to CBK completion. Further analysis related to gender will be discussed as applicable in each of the remaining five research questions.

Female students are taking statistically significant less time to complete CBK than male students with a low probability of the result being obtained by chance (p=.008 or p<.01) and statistical significance at the 0.01 level. Within the context of variables used for this study, where total R^2 is 0.193 and adjusted R^2 is 0.186, gender contributes a mere 0.6% or less than 1% to the overall relationship of completion of CBK and thereby student progression to upper division status.

Question 2

What is the relationship between ethnicity and time to completion of CBK?

Student data was coded 1 = minority (Hispanic, African American, Native American) and zero (0) = non-minority (White, Asian) with regard to student status. Table 7 indicates descriptive parameters for the two groups. The beta weight (β) was 0.020 with an effect size of R^2 of 0.011. The adjusted R^2 was 0.007.

Table 10 indicates that non-minority (White and Asian) students are completing CBK on average in less time (μ =2.61 semesters) than underrepresented minority students (African American, Hispanic, Native American), who complete CBK in a mean of 2.82 semesters. The variance in time to completion of CBK is greater for minority engineering students (σ =1.00) than for non-minority engineering students (σ = 0.94).

Table 10
Descriptive Parameters by Minority Status

	N	Mean	σ
Minority	116	3.07	1.019
Non-minority	1049	2.75	0.98

Table 11 indicates results of a t-test for Minority and Non-Minority student status. Levene's Test for Equality resulted in F = 0.242 and p = 0.623; therefore, since there was no statistical significance, equal variances are assumed.

Table 11

t-test for Minority of Non-Minority Status

			95% Confidence Interval of the Difference	
	t	**Sig. (2-tailed)**	**Lower**	**Upper**
Equal variances assumed	-3.310	.001**	-0.508	-0.130

**Significance at .01 level

Results in Table 11 indicate a statistically significant difference at the 0.01 level (p = .001) in mean time to completion of CBK between minority and non-minority students. Since the t-test for minority or non-minority status was statistically significant (p-0.001) then further analysis by individual ethnic groups was warranted. Table 12 indicates number and percentage for the five ethnic groups used in this study. White students are a considerable majority (83.4%) of the engineering students in this study.

Table 12
Completion of CBK by Ethnicity

	N	Percent
Asian	77	6.6
African American	30	2.6
Hispanic	84	7.2
Native American	2	0.2
White	972	83.4
Total	1165	100.0

Data was disaggregated by ethnicity for descriptive and statistical analysis by ethnic group. Table 13 indicates that Asian students finish CBK in the shortest time period (μ = 2.73 semesters as the mean) followed by White students (μ = 2.75

semesters). African American students took the longest of the four ethnicities to complete CBK (μ = 3.23 semesters), and was the only ethnic group to have no individuals completing CBK in 1 semester. The White, Hispanic and Asian ethnic groups all had individuals who completing CBK in 1 semester. The maximum number of semesters to complete CBK was six semesters for all four ethnic groups analyzed in RQ2. The small number of Native American students (N=2) shown in Table 13 does not allow for accurate statistical analysis of that group, so when further analysis was conducted by ethnic groups, Native American figures were not disaggregated.

Analysis of the data was performed by conducting t-tests for each of four ethnic

Table 13
Frequency, Mean and Standard Deviation (σ)
for Time to Completion by Ethnicity

	Minimum	Maximum	Mean	(σ)
Asian	1	6	2.73	1.13
African American	2	6	3.23	1.04
Hispanic	1	6	3.00	.99
White	1	6	2.75	.97

groups: African American, Hispanic, Asian, and White. Tables on pages 85-89 indicate the descriptive parameters and t-test results for the four primary ethnic groups: African American, Hispanic, Asian, and White.

Figure 3 indicates Semester to Upper Division Progression, or completion of CBK by ethnicity and number of students.

Figure 3: Semesters to Upper Division Progression by Ethnicity

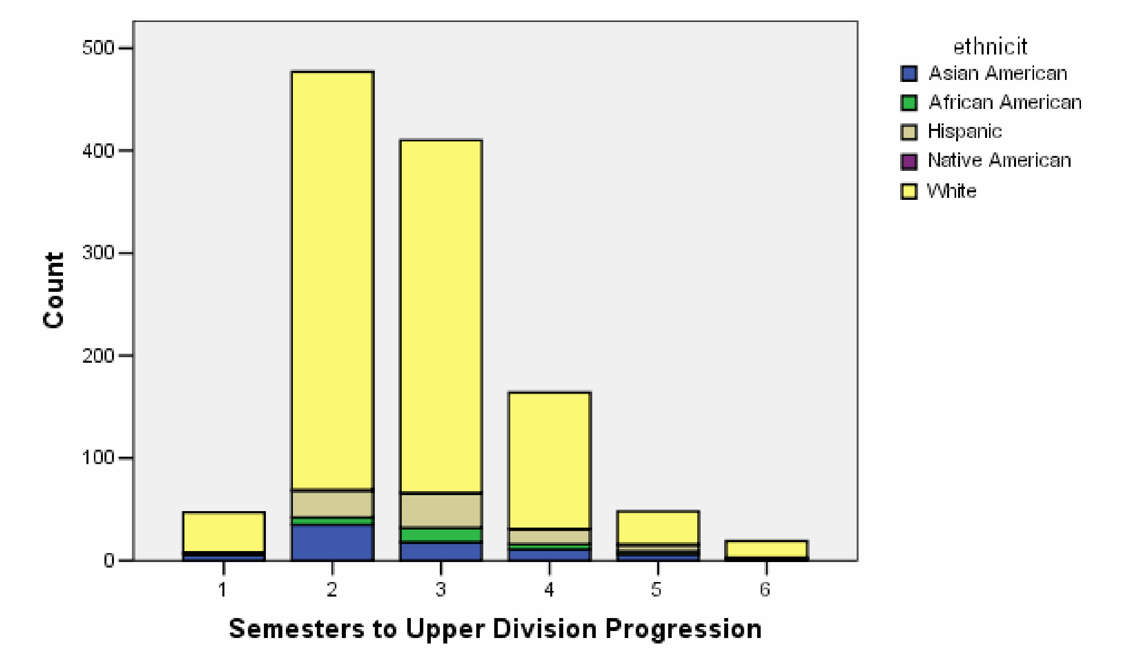


Table 14 shows that African American students in this study had a σ = 1.04) that differed from that of non-African American students (σ = of 0.98) indicating a greater variance in time to completion of CBK by the African American group. African American students are taking on average longer to complete CBK (μ = 3.23 semesters) than all other students (μ = 2.77 semesters).

Table 14
Descriptive Parameters- African American Students

	N	Mean	σ
African American	30	3.23	1.04
Non-African American	1135	2.77	.98

Levene's Test for Equality was conducted for African American engineering students compared to non-African American ethnicities, and resulted in F = .007 and p = 0.935. Since there was no significance, equal variances are assumed with results shown in Table 12. African American student time-to-completion of CBK is statistically different from time to completion of non-African American students at the .05 level (p = 0.011) with results shown in Table 15.

Table 15
t-test – African American Students

			95% Confidence Interval of the Difference	
	t	**Sig. (2-tailed)**	**Lower**	**Upper**
Equal variances assumed	-2.541	0.011*	-0.82	-0.11

*Significant at .05 level

Table 16 indicates descriptive parameters for Asian students compared to non-Asian students. Asian students had a σ (1.13) that differed from that of non-Asian students (σ = 0.98) indicating a greater variance in time to completion of CBK by the Asian group. Very little difference in the mean time to completion exists between Asian students (μ = 2.73 semesters) and all other students (μ = 2.79 semesters).

Table 16
Descriptive Parameters- Asian Students

	N	**Mean**	**σ**
Asian	77	2.73	1.13
Non-Asian	1088	2.79	.98

Levene's Test for Equality of Asian or non-Asian students resulted in F = 4.930 and p = 0.027; therefore, since there was significance, equal variances are not assumed. Results in Table 17 indicate that there is not a significant difference (p= 0.659) in the time to completion between Asian students and non-Asian students.

Table 17
t-test for Asian Students

			95% Confidence Interval of the Difference	
	t	**Sig. (2-tailed)**	**Lower**	**Upper**
Equal variances not assumed	0.443	.659	-0.20	0.32

Table 18 indicates that on the average, Hispanic students are taking longer (μ = 3.00 semesters) to complete CBK than did non-Hispanic students (μ = 2.77 semesters). Both Hispanic and non-Hispanic students had a σ = 0.99 indicating no difference of variance in time to completion of CBK.

Table 18
Descriptive Parameters - Hispanic Students

	N	**Mean**	**σ**
Hispanic	84	3.00	.99
Non-Hispanic	1081	2.77	.99

Because the variance is exactly equal for Hispanic and non-Hispanic students (σ = 0.99), the equal variance assumption was met and results are shown in Table 19.

These results indicate that there is a statistically significant difference (p= 0.036) at the 0.05 level in the time to completion between Hispanic and non-Hispanic students.

Table 19
t-test for Hispanic Students

			95% Confidence Interval of the Difference	
	t	**Sig. (2-tailed)**	**Lower**	**Upper**
Equal variances assumed	-2.102	0.036*	-0.45	-1.57E-02

*Significant at 0.05 level

Table 20 indicates White students complete CBK faster, or in a mean of 2.75 semesters versus 2.93 semesters for non-White students. White students have a $\sigma = 0.97$ compared with non-white students with a $\sigma = 1.08$ indicating a greater variance in time to completion of CBK by the non-White group.

Table 20
Descriptive Parameters- White Students

	N	**Mean**	σ
White	972	2.75	.97
Non-white	193	2.93	1.08

Levene's Test for Equality of White or non-White students resulted in F = 1.355 and p = 0.245. Since there was not statistical significance, equal variances are assumed with results shown in Table 20. Results in Table 21 indicate statistical significance at the 0.05 level for time to completion between White students and non-White students.

Table 21
t-test for White Students

	t	Sig. (2-tailed)	95% Confidence Interval of the Difference Lower	Upper
Equal variances assumed	2.323	.020*	2.81E-02	.33

*Significant at 0.05 level

Since African American, Hispanic, and White students showed statistical significance at the 0.05 level, statistical analysis with t-tests were also conducted for comparison of the three groups.

Table 22 indicates that African American students on the average take longer to complete CBK than Hispanic students, $\mu = 3.23$ versus $\mu = 3.00$ semesters. A slightly greater variance in time to completion of CBK exists for African American students ($\sigma = 1.04$) than Hispanic students ($\sigma = .99$).

Table 22
Descriptive Parameters- African American-Hispanic Students

	N	Mean	σ
African American	30	3.23	1.04
Hispanic	84	3.00	.99

Levene's Test for Equality of African American and Hispanic students resulted in F = .300 and p = 0.585. Since there was no statistical significance, equal variances are assumed with results shown in Table 23. Results of t-test in Table 23 indicate no statistical significance between African American and Hispanic students in time to completion of CBK.

Table 23
t-test for African American and Hispanic Students

			95% Confidence Interval of the Difference	
	t	**Sig. (2-tailed)**	**Lower**	**Upper**
Equal variances assumed	1.090	.278	-0.191	0.657

Table 24 indicates that African American students take longer to complete CBK than White students, 3.23 versus 3.00 semesters. A slight variance in time to complete CBK exists for African American students (σ = 1.04) and White students (σ= 0.99).

Levene's Test for Equality of African American and White students resulted in F = .039 and p = 0.844. Since there was no statistical significance, equal variances are assumed with results shown in Table 22. Results in Table 25 indicate statistical

Table 24
Descriptive Parameters- African American-White Students

	N	**Mean**	**σ**
African American	30	3.23	1.04
White	972	2.75	.97

significance at the 0.01 level (p=0.008) for time to completion of CBK between African American and White students.

Table 25
t-test for African American and White Students

	t	Sig. (2-tailed)	95% Confidence Interval of the Difference Lower	Upper
Equal variances assumed	2.677	.008**	0.128	0.834

**Statistical significance at 0.01 level

Table 26 indicates that on the average Hispanic students ($\mu = 3.00$ semesters) take longer to complete CBK than White students ($\mu = 2.75$ semesters). A very slight variance in time to completion of CBK exists for Hispanic students ($\sigma = 0.99$) and White students ($\sigma = 0.97$).

Table 26
Descriptive Parameters- Hispanic and White Students

	N	Mean	σ
Hispanic	84	3.00	0.99
White	972	2.75	0.97

Levene's Test for Equality of Hispanic and White students resulted in $F = 0.734$ and $p = 0.392$. Since there was no statistical significance, equal variances are assumed with results shown in Table 27. Results indicate statistical significance at the 0.05 level ($p=0.025$) for time to completion of CBK between Hispanic and White students.

Table 27
t-test for Hispanic and White Students

			95% Confidence Interval of the Difference	
	t	**Sig. (2-tailed)**	**Lower**	**Upper**
Equal variances assumed	2.248	.025*	0.032	0.464

*Statistical significance at 0.05 level

Ethnicity and Gender

Since t-test results were statistically significant for three of the ethnic groups (African American, Hispanic, White) and for gender, further analysis is warranted related to ethnicity and gender. Table 28 shows that the breakdown for completion of CBK for each of the six semesters by ethnicity and gender. Of the 1165 student, 47 completed CBK in 1 semester, 477 in two semesters, 410 in three semesters, 164 in four semester, 48 in five semesters, and 19 in six semesters. There were 205 females with 32 being African American or Hispanic and 960 males, 71 being African American, Hispanic or Native American.

Table 28 indicates there are only two Hispanic males that completed CBK in one semester and no African American or Native American students that completed CBK in one semester. Males outnumber females by more than 2:1 in completion of CBK in only one semester, which is below the majority of student (76%) completing CBK by the end of three semesters. White males are the largest number of students completing CBK in four, five or six semesters, which is longer than the average time to completion of between two and three semesters. There were more Asian, African American, and Hispanic males than females who took four to six semesters to complete CBK.

Table 28
Semesters to Completion of CBK by Ethnicity and Gender

	Semesters to Completion of CBK					
	1	**2**	**3**	**4**	**5**	**6**
African Am.	0	7	14	5	3	1
Female	0	5	8	3	1	0
Male	0	2	6	2	2	1
Hispanic	2	26	34	15	6	1
Female	0	3	7	5	0	0
Male	2	23	27	10	6	1
White	39	408	344	133	32	16
Female	10	73	49	17	3	1
Male	29	335	295	116	29	15
Asian	6	35	18	11	6	1
Female	2	11	2	2	0	1
Male	4	24	16	9	6	0
Other (Native Am)	0	1	0	0	1	0
Female	0	0	0	0	0	0
Male	0	1	0	0	1	0
Total	47	477	410	164	48	19

Table 29 indicates the Descriptive Parameters for African American students in this study by gender. African American females are taking less time to complete CBK than African American males with less variance ($\sigma = 0.866$) in their time to completion of CBK than males ($\sigma = 1.198$).

Table 29
Descriptive Parameters- African American Students by Gender

African Am.	**N**	**Mean**	**σ**
Male	13	3.54	1.198
Female	17	3.00	.866

Levene's Test for Equality of African American students and gender resulted in F = 2.713 and p = 0.111. Since there was no statistical significance, equal variances are assumed with results shown in Table 30. Results in Table 30 indicate no statistical significance (p=0.164) for time to completion of CBK between African American males and African American females.

Table 30
t-test for African American Male and Female Students

			95% Confidence Interval of the Difference	
	t	**Sig. (2-tailed)**	**Lower**	**Upper**
Equal variances assumed	1.430	.164	-0.233	1.310

Table 31 shows Descriptive Parameters for Asian students in this study by gender. Asian females are taking less time (μ = 2.44 semesters) to complete CBK than Asian males (μ = 2.81 semesters). Asian female students have more variance (σ = 1.199) in their time to completion of CBK than Asian males (σ = 1.106).

Table 31
Descriptive Parameters- Asian Students by Gender

Asian	**N**	**Mean**	**σ**
Male	59	2.81	1.106
Female	18	2.44	1.199

Levene's Test for Equality of Asian students and gender resulted in F = 0.059 and p = 0.809. Since there was no statistical significance, equal variances are assumed with results shown in Table 32. Results in Table 32 indicate no statistical significance ($p=0.228$) for time to completion of CBK between Asian males and Asian females.

Table 32
t-test for Asian Male and Female Students

			95% Confidence Interval of the Difference	
	t	**Sig. (2-tailed)**	**Lower**	**Upper**
Equal variances assumed	1.215	.228	-0.236	0.974

Table 33 indicates the Descriptive Parameters for Hispanic students in this study by gender. Hispanic females are taking less time to complete CBK (μ =2.88 semesters) than Hispanic males, who complete CBK on average in μ = 3.03 semesters. Variance in their time to completion of CBK is very similar for Hispanic males (σ = 1.00) and Hispanic females (σ = 0.993).

Table 33
Descriptive Parameters- Hispanic Students by Gender

Hispanic	N	Mean	σ
Male	67	3.03	1.000
Female	17	2.88	.993

Levene's Test for Equality of Hispanic students and gender resulted in F = .017 and p = 0.898. Since there was no statistical significance, equal variances are assumed with results shown in Table 34. Results in Table 34 indicate no statistical significance ($p=0.588$) for time to completion of CBK between Hispanic males and Hispanic females.

Table 34
t-test for Hispanic Male and Female Students

			95% Confidence Interval of the Difference	
	t	**Sig. (2-tailed)**	**Lower**	**Upper**
Equal variances assumed	.544	.588	-0.392	0.687

Table 35 indicates the Descriptive Parameters for White students in this study by gender. White females are taking less time to complete CBK ($\mu = 2.56$ semesters) than White males ($\mu = 2.79$) with less variance ($\sigma = 0.895$) in their time to completion of CBK than males ($\sigma = 0.977$).

Table 35
Descriptive Parameters- White Students by Gender

White	N	Mean	σ
Male	819	2.79	.977
Female	153	2.56	.895

Levene's Test for Equality for White students and gender resulted in $F = .345$ and $p = 0.557$. Since there was no statistical significance, equal variances are assumed with results shown in Table 36. Results in Table 36 indicate statistical significance ($p=0.008$) for time to completion of CBK between White males and White females.

Table 36
t-test for White Male and Female Students

			95% Confidence Interval of the Difference	
	t	**Sig. (2-tailed)**	**Lower**	**Upper**
Equal variances assumed	2.654	.008**	0.059	0.392

** Statistical Significance at 0.01 level

Table 28 indicates the vast majority of students, or 887 students, complete CBK by 3 semesters. This is 76% of students in the study. Of the 47 students that complete CBK at the fastest rate possible of only one semester, 45 are non-minority (39 White; 6 Asian) students. There are 231 students taking longer than average to complete CBK, or completing CBK in 4, 5, or 6 semesters which is above the majority of students finishing CBK in 3 semesters. The largest ethnicity in the group was White and the greatest number was male students.

Ethnicity is a statistically significant factor in the completion of CBK or progression to upper level status at the 0.05 level for three of the four groups studied: African American ($p = 0.011$), Hispanic ($p = 0.036$), and White ($p = 0.020$). Asian students as a whole completed CBK the fastest of all groups, but without statistical significance so the results could be attributed to chance. This is shown by a p value of 0.615, the largest of all four groups, where the higher p ($p > .05$) value indicates a high probability of the results being obtained by chance.

Statistical significance for gender and ethnicity was found between African American and White students ($p = .008$) and between White male and White female students ($p = .008$).

The effect size of R^2 of 0.011 an adjusted R^2 of 0.007 for RQ2 indicates that though significant, ethnicity only contributes 1% or less to the relationship of all the variables in this study on time to completion of CBK.

Question 3

What is the relationship between a student's unmet financial need and time to completion of CBK?

A study by Bresciani and Carson (2002) finds that the financial aid calculation of unmet financial need is a predictor of student persistence. These facts coupled with pending legislation in the 2005-2006 student loan reauthorization process currently underway in Congress influenced the use in this study of defining the relationship of time to completion based on student unmet financial need (Field, 2005).

For this question, students not having unmet financial need (UFN) were coded as zero and those with UFN were coded as one. Students not applying or qualifying for financial need were coded as not having UFN.

Table 37 indicates that of the 1165 student in this study, 925 (81%) did not have Unmet Financial Need (UFN), and 240 students (20%) had UFN. Students without UFN are completing CBK faster (μ = 2.73 semesters) than those with UFN (μ =2.98 semesters). A slightly greater variance in time to completion of CBK exists for student with UFN (σ =1.02) than for student without UFN (σ = 0.97). The beta weight (β) for RQ3 was 0.063 with an effect size or R^2 of 0.01 and adjusted R^2 of 0.009. The UFN variable contributes less than 1% (R^2 of 0.01 and adjusted R^2 of 0.009) to the total 19% effect size (R^2) of all the variables in this study related to time to completion of CBK.

Table 37
Descriptive Statistics by Financial Need

	N	Minimum	Maximum	Mean	σ
No UFN	925	1	6	2.73	0.97
UFN	240	1	6	2.98	1.02

Table 38 indicates the results of a t-test for financial need and time to completion of CBK. Levene's Test for Equality of students with UFN and those not having UFN resulted in F = .393 and p = 0.531. Since there was no statistical significance, equal variances are assumed, and results indicate statistical significance at the 0.01 level (p=0.001) for time to completion of CBK between students with UFN and those without UFN.

Table 38
t-test for Unmet Financial Need

			95% Confidence Interval of the Difference	
	t	**Sig. (2-tailed)**	**Lower**	**Upper**
Equal variances assumed	3.486	.001**	0.109	0.388

**Statistical significance at 0.01 level

Results in Table 38 indicate statistical significance at the 0.01 level for UFN. Since the study also found statistical significance for financial need, gender, and certain ethnicities, further data analysis is needed for UFN and these variables.

Unmet Financial Need and Gender

Table 39 indicates completion of CBK by financial need and gender. The majority of the population, or 76%, completed CBK in 2 or 3 semesters (477+410= 877).

Table 39
Semesters to Completion of CBK by Financial Need and Gender

	Semesters to Completion of CBK											
	1	**%**	**2**	**%**	**3**	**%**	**4**	**%**	**5**	**%**	**6**	**%**
No UFN	**39**	**83%**	**401**	**84%**	**317**	**77%**	**122**	**74%**	**30**	**62%**	**16**	**84%**
Female	10	26%	83	21%	49	15%	23	19%	3	10%	1	6%
Male	29	74%	318	79%	268	85%	99	81%	27	90%	15	94%
UFN	**8**	**7%**	**76**	**16%**	**93**	**24%**	**42**	**26%**	**18**	**38%**	**3**	**16%**
Female	4	50%	9	12%	17	18%	4	10%	1	6%	1	33%
Male	4	50%	67	88%	76	82%	38	90%	7	94%	2	67%
Total	**47**	**4%**	**477**	**41%**	**410**	**35%**	**164**	**14%**	**48**	**4%**	**19**	**2%**

There were 169 females (18.3%) and 756 male (81.7%) students without UFN. This is proportional to the enrollment number for male and female students. Of the 240 students with UFN, 63 or 26% took longer than three semesters to complete CBK. There were 36 female students (15%), and 204 male students (85%) with UFN in this study. In either category of having or not having UFN, the majority of those taking more than three semesters to complete CBK were males.

Table 40 indicates that females with no UFN are taking less time to complete CBK (μ = 2.58 semesters) than females who have UFN (μ = 2.78 semesters). The variance in time to completion for females without UFN (σ = 0.904) is less than for females with UFN (σ = 1.072).

Table 40
Descriptive Statistics Females and Financial Need

Female	N	Mean	σ
No UFN	169	2.58	.904
UFN	36	2.78	1.072

Table 41 indicates the results of a t-test for UFN and females for time to completion of CBK. Levene's Test for Equality of female students with UFN resulted in F = 0.077 and p = 0.781, so equal variances are assumed. Statistical significance was not found for time to completion of CBK and UFN for females.

Table 41
t-test for UFN for Females

			95% Confidence Interval of the Difference	
	t	Sig. (2-tailed)	Lower	Upper
Equal variances assumed	-1.153	0.250	-0.536	0.140

Table 42 indicates males with no UFN are taking less time to complete CBK (μ = 2.76 semesters) than males who have UFN (μ = 3.01 semesters). The variance in time to completion for males without UFN (σ = 0.986) is slightly less than for males with UFN (σ = 1.01).

Table 42
Descriptive Statistics Males and UFN

Male	N	Mean	σ
No UFN	756	2.76	.986
UFN	204	3.01	1.01

Table 43 indicates the results of a t-test for UFN of males for time to completion of CBK. Levene's Test for Equality of UFN for male students resulted in F = 0.205 and p = 0.651. Since there was no statistical significance, equal variances are assumed, and statistical significance was found at the 0.01 level (p = 0.001) for time to completion of CBK and UFN for males.

Table 43
t-test for UFN for Males

			95% Confidence Interval of the Difference	
	t	**Sig. (2-tailed)**	**Lower**	**Upper**
Equal variances assumed	-3.199	0.001**	-0.404	-0.097

**Statistical Significance found at the 0.01 level

Unmet Financial Need and Ethnicity

Table 44 indicates the results of Financial Need and ethnicity.

Table 44
Semesters to Completion of CBK by Financial Need and Minority Status

	Semesters to Completion of CBK											
	1	**%**	**2**	**%**	**3**	**%**	**4**	**%**	**5**	**%**	**6**	**%**
No UFN	**39**	**83%**	**401**	**84%**	**317**	**77%**	**122**	**74%**	**30**	**62%**	**16**	**84%**
Minority	2	83%	20	5%	27	9%	9	7%	2	7%	1	6%
Not Min.	37	95%	381	95%	290	91%	113	93%	28	93%	15	94%
UFN	**8**	**7%**	**76**	**16%**	**93**	**24%**	**42**	**26%**	**18**	**38%**	**3**	**16%**
Minority	0		14	18%	21	23%	11	26%	8	44%	1	33%
Not Min.	8	100%	62	82%	72	77%	31	74%	10	56%	2	67%
Total	**47**	**4%**	**477**	**41%**	**410**	**35%**	**14%**	**4%**	**48**	**4%**	**19**	**2%**

Review of the literature suggests that studies normally analyze parameters by minority versus non-minority student status prior to disaggregating between ethnicity groups. Levene's Test for Equality of the variables ethnicity and UFN related to completion of CBK resulted in F = 0.205 and p = .651. Since no statistical significance was found, equal variances are assumed with results shown in Table 45. Statistical significance was found at the 0.01 level (p = 0.001) so further analysis is merited for UFN by individual ethnicities.

Table 45
t-test for Financial Need and Ethnicity

			95% Confidence Interval of the Difference	
	t	**Sig. (2-tailed)**	**Lower**	**Upper**
Equal variances assumed	-3.199	.001**	-0.404	-0.097

**Statistical significance at 0.01 level

Table 46 indicates semesters to completion of CBK with UFN or no UFN by ethnicity. Of the 925 students without UFN there are 53 Asians (5.7%), 13 African Americans (1.4%), 47 Hispanics (5.1%), 1 Native American (0.1%), and 811 Whites (87.7%). Of those students with UFN there are 24 Asians (10%), 17 African Americans (7.1%), 37 Hispanics (15.4%), 1 Native American (0.4%), 161 Whites (67.1%). Underrepresented minority students (Hispanic, African American) have a larger number of students with UFN than not having UFN.

Table 46
Semesters to Completion of CBK by Financial Need by Ethnicity

	Semesters to Completion of CBK											
	1	**%**	**2**	**%**	**3**	**%**	**4**	**%**	**5**	**%**	**6**	**%**
No UFN	**39**	**83%**	**401**	**84%**	**317**	**77%**	**122**	**74%**	**30**	**62%**	**16**	**84%**
Afr. Am.	0	0%	4	1%	6	2%	2	1%	0	0%	1	6%
Hispanic	2	5%	15	4%	21	7%	7	6%	2	7%	0	0%
White	34	88%	352	88%	280	88%	105	86%	25	83%	15	94%
Asian	3	7%	29	7%	10	3%	8	7%	3	10%	0	0%
Nat. Am.	0	0%	1	0.2%	0	0%	0	0%	0	0%	0	0%
UFN	**8**	**7%**	**76**	**16%**	**93**	**24%**	**42**	**26%**	**18**	**38%**	**3**	**16%**
Afr. Am.	0	0%	3	4%	8	9%	3	7%	3	17%	0	0%
Hispanic	0	0%	11	14%	13	14%	8	19%	4	22%	1	33%
White	5	63%	56	74%	64	68%	28	67%	7	39%	1	33%
Asian	3	37%	6	8%	8	9%	3	7%	3	17%	1	33%
Nat. Am.	0	0%	0	0%	0	0%	0	0%	1	5%	0	0%
Total	**47**	**4%**	**477**	**41%**	**410**	**35%**	**14%**	**4%**	**48**	**4%**	**19**	**2%**

% may not equal 100% due to rounding

Table 47 shows descriptive statistics for unmet financial need by ethnicity. Native American students have the lowest of UFN and highest number of semesters to complete CBK of students with UFN. However, their numbers are so small that results for this category are not considered to be accurate for this study and are not displayed in subsequent tables and analysis.

Table 47
Demographic Statistics for UFN by Ethnicity

No UFN Ethnicity	Frequency	Mean	σ
Asian	53	2.60	1.01
African American	13	3.08	1.12
Hispanic	47	2.83	0.89
Native American*	1	2.00	0.00
White	811	2.73	0.97
Total	**925**	**2.73**	**0.97**
Having UFN Ethnicity	**Frequency**	**Mean**	**σ**
Asian	24	3.00	1.35
African American	17	3.35	1.00
Hispanic	37	3.22	1.08
Native American*	1	5.00	0.00
White	161	2.87	0.93
Total	**240**	**2.98**	**1.02**

* Number too small for accurate calculation

Students taking the longest number of semesters to complete CBK are those with UFN who are African American ($\mu = 3.35$ semesters; $\sigma = 1.00$) and Hispanic ($\mu = 3.22$ semesters; $\sigma = 1.08$) students. African American students without UFN ($\mu = 3.08$ semesters; $\sigma = 1.12$) are also taking just slightly longer than the median completion rate of 3 semesters. All of the other ethnic groups in this study, with the exception of Native

Americans, are taking 3.0 or less semester to complete CBK regardless of having or not having UFN. Of those with no UFN, the ethnic group with the greatest variance is African American (σ = 1.12) with Hispanics being the group with the least variance (σ = 0.89). For students with UFN, the variance in time to completion of CBK ranges from Asian (σ = 1.35) to White students (σ = 0.93).

A one-way ANOVA was conducted for each of the four ethnicity groups as to having or not having UFN as it relates to time to complete CBK and progress to upper division status in the College of Engineering. Coding for ethnicity was 2=Asian; 3=African American; 4=Hispanic; 5= Native American; and 6= White. Due to the small number of Native Americans, an ANOVA was not conducted for this ethnic group.

Table 48 indicates the one-way ANOVA results for UFN and Asian students' relationship to CBK. The beta weight (β) for UFN and Asian students for time to completion of CBK was .0163, and effect size of R^2 was 0.027 with an adjusted R^2 of 0.014 indicating that this combined grouping represented less than 2% as a combination of factors of time to CBK completion. No statistical significance was found (t = 1.433, p = 0.156).

Table 48
ANOVA for UFN and Asian Students[b,c]

	DF	SS	MS	F	Sig.
Regression	1	2.593	2.593	2.054	0.156[a]
Residual	75	94.679	1.262		
Total	76	97.273			

a. Predictors: (Constant), Unmet Financial Need
b. Dependent variable: Semester to CBK completion
c. Selecting only cases for which Ethnicity = Asian

Table 49 indicates the one-way ANOVA results for UFN and African American students. The beta weight (β) for UFN and African American students for time to completion of CBK was 0.134, and effect size or R^2 was .018 with an adjusted R^2 of 0.017 indicating that this combined grouping of variables represents a contribution of approximately 2% as a combination of factors in time to CBK completion. No statistical significance was found (t = 0.714, p = 0.481).

Table 49
ANOVA for UFN and African American Students[b,c]

	DF	SS	MS	F	Sig.
Regression	1	.561	.561	.510	0.481[a]
Residual	28	30.805	1.100		
Total	29	31.367			

a Predictors: (Constant), Unmet Financial Need
b Dependent variable: Semester to CBK completion
c Selecting only cases for which Ethnicity = African American

Table 50 indicates the one-way ANOVA results for UFN and Hispanic engineering students. The beta weight (β) for UFN and Hispanic students for time to completion of CBK was 0.194, and effect size or R^2 was 0.038 with an adjusted R^2 of 0.026 indicating that this combined grouping represented a contribution of almost 4% as a combination of factors in time to CBK completion. No statistical significance was found (t = 1.792, p = 0.077).

Table 50
ANOVA for UFN and Hispanic Students[b,c]

	DF	SS	MS	F	Sig.
Regression	1	3.091	3.091	3.213	0.077[a]
Residual	82	78.909	0.962		
Total	83	82.000			

a Predictors: (Constant), Unmet Financial Need
b Dependent variable: Semester to CBK completion
c Selecting only cases for which Ethnicity = Hispanic

Table 51 indicates the one-way ANOVA results for UFN and White students. The beta weight (β) for UFN and White students for time to completion of CBK was 0.054, and effect size or R^2 was 0.003 with an adjusted R^2 of 0.002 indicating that this combined relationship represented a contribution of less than 1% (0.2%) as a combination of factors in time to CBK completion. No statistical significance was found ($t = 1.688$, $p = 0.092$).

Table 51
ANOVA for UFN and White Students[b,c]

	DF	SS	MS	F	Sig.
Regression	1	2.664	2.664	2.851	.092[a]
Residual	970	906.581	0.935		
Total	971	909.246			

a Predictors: (Constant), Unmet Financial Need
b Dependent variable: Semester to CBK completion
c Selecting only cases for which Ethnicity = White

The majority of students (81%) in this study do not have UFN. Those with UFN are taking slightly longer to complete CBK at $\mu = 2.98$ semesters versus $\mu = 2.73$

semesters for those without unmet need. The variance of the mean time to completion of CBK related to UFN within the group of males ($\sigma = 0\ .99$) and within the group of females ($\sigma = 0\ .90$) groups were similar.

UFN had a statistically significant relationship to time to completion of CBK ($p = .001$), indicating that this factor impacts the length of time a student with need takes to progress to upper level status. It would be assumed that this also will impact time to ultimate progression toward degree or graduation. However, the effect size was very small (adjusted R^2 of 0.009) indicating that the UFN variable contributes little to the overall time to completion of CBK.

Since UFN was significant, further analyses were conducted. First, gender was examined. Coding for gender related to UFN was 0 for males and 1 for females, so a negative r indicates that females with UFN ($r = -0.083$) and without UFN ($r = -0.073$) are finishing faster than males in both groups. However, without statistical significance ($p = .20$), the difference is within the statistical margin of error.

UFN by ethnicity did not result in findings that were statistically significant at either the 0.01 or 0.05 levels. Correlation between minority status and time to completion of CBK for no UFN was $r = 0.005$ and for UFN $r = -0.117$ indicating very little correlation between UFN and minority/non-minority.

Question 4

What is the relationship between student major and time to completion of CBK?

In 1999, there were 331,948 students enrolled as undergraduates in engineering colleges across the United States (American Society for Engineering Education, 2005).

Table 52 lists the 1999 national undergraduate engineering enrollment for the five engineering majors in this study. Nationally, of the five majors in this study, are 1) Computer Engineering, 2) Mechanical engineering, 3) Civil Engineering, 4) Chemical Engineering, and 5) Electrical Engineering.

Table 52
1999 Number and Percent of National Engineering Undergraduate Enrollment by Major

Major	N	Percent of Total Enrollment
Chemical Engineering	27,379	12.3
Civil Engineering	38,213	17.2
Computer Engineering	73,550	33.2
Electrical Engineering	18,302	8.3
Mechanical Engineering	64,404	29.0
Total	221,848	100

Source: *2005 Profiles of Engineering and Engineering Technology Colleges*

Table 53 indicates the number and percentage of TAMU students in the five engineering majors selected for this study. These five majors were selected for consideration based on national data and since the majority of engineering colleges in the United States offer these core disciplines. For this study enrollment ranking by the five majors was 1) Mechanical Engineering, 2) Computer Engineering, 3) Chemical Engineering, 4) Electrical Engineering and 5) Civil Engineering. The top two nationally and the top two at TAMU are mechanical and computer engineering (Tables 52, 53).

Table 53
Number and Percent of TAMU Engineering Students by Major for This Study

Major	N	Percent
Chemical Engineering	213	18.3
Civil Engineering	137	11.8
Computer Engineering	251	21.5
Electrical Engineering	203	17.4
Mechanical Engineering	361	31.0
Total	1165	100.0

As shown in Table 54, by major the mean time to completion of CBK is between 2.56 semesters (chemical engineering) and 2.96 semesters (computer engineering). All but chemical engineering have a median time to completion of 3 semesters, which matches the median of the population. Civil Engineering majors have the smallest variance ($\sigma = 0.88$) with Computer ($\sigma = 1.0$) and Mechanical ($\sigma = 1.01$) Engineering having larger variances in the time to completion of CBK.

Table 54
Mean and Standard Deviation for Time to Completion by Major

Major	Minimum	Maximum	Mean	σ
Chemical Engineering	1	6	2.56	0.99
Civil Engineering	1	6	2.72	0.88
Computer Engineering	1	6	2.96	1.00
Electrical Engineering	1	6	2.73	0.95
Mechanical Engineering	1	6	2.84	1.01

For the variable major, the effect size or R^2 was 0.018 with an adjusted R^2 of 0.015. The variable "Major" therefore contributes less than 2% of the total 19% effect size (R^2) of all the variables in this study related to time to completion of CBK.

Table 55 indicates the one-way ANOVA results for the variable Major. Dummy variables were created for mechanical, chemical, electrical, and computer engineering with 1 = major of variable and 0 = other majors. However, to run statistical analysis a variable has to be left out to satisfy the N-1 calculation. Since Civil Engineering had the least number of students for this study, it was left out, and the remaining majors were mechanical, chemical, electrical, and computer engineering. Statistical significance was found at the 0.01 level (p = 0.0003) for major related to time to completion of CBK.

The variable "Major" contributes less than 2% of the total 19% effect size (R^2), and is a minor contributor among this study's variables related to time to completion of CBK.

Table 55
ANOVA[b] for Major

	DF	SS	MS	F	Sig.
Regression	4	20.400	5.100	5.300	**.0003a
Residual	1160	1116.22	0.962		
Total	1164	1136.621			

a Predictors: (Constant), ME, Ch, EE, Computer
b Dependent variable: Semester to CBK completion
** Significance at the 0.0l level

Table 56 indicates the beta weights (β) for the four majors. Statistical significance was found at the 0.05 level (p = 0.021) for Computer Engineering majors and their relationship to completion of CBK.

Table 56
Coefficients[a] Major

	Unstandardized Coefficients		Standardized Coefficients		
	B	**Std. Error**	**Beta**	**t**	**Sig.**
(Constant)	2.715	0.084		32.399	.000
Computer Eng.	0.241	0.104	0100	2.311	*0.021
Electrical Eng.	0.014	0.108	0.005	0.127	0.899
Chemical Eng.	-0.152	0.107	-0.059	-1.414	0.158
Mechanical Eng.	0.130	0.098	0.061	1.316	0.188

[a] Dependent variable: Semester to CBK completion
* Statistical Significance found at the 0.05 level

Major and Gender

Table 57 indicates the semesters to completion of CBK for the five majors by gender. In Computer Engineering there were 251 students (216 male; 35 female) with a mean of 2.96 semesters to completion of CBK and a SD of 1.00 semester. Electrical Engineering had 203 students (173 males; 30 females) with a mean of 2.73 semesters and a SD of 0.95. Chemical Engineering had 213 majors (139 males; 74 females) with a mean of 2.56 semesters and a SD of 0.99. Chemical Engineering had the largest number of females of the five majors used in this study. Mechanical Engineering had 361 students (318 males; 43 females) with a mean of 2.84 semesters and $\sigma = 1.01$. Mechanical engineering had the largest number of majors of the five majors used in this study. Civil Engineering had 137 students (114 males; 23 females) with a mean of 2.72 semesters and σ = 0.88.

Table 57
Semesters to CBK Completion for Major and Gender

	Semesters to Completion of CBK					
	1	**2**	**3**	**4**	**5**	**6**
Computer Eng	**6**	**80**	**110**	**36**	**12**	**7**
Female	1	12	15	5	1	1
Male	5	68	95	31	11	6
Electrical Eng	**5**	**94**	**70**	**21**	**11**	**2**
Female	2	16	8	4	0	0
Male	3	78	62	17	11	2
Chemical Eng	**18**	**103**	**57**	**27**	**5**	**3**
Female	7	37	21	7	1	1
Male	11	66	36	20	4	2
Mechanical Eng	**14**	**142**	**118**	**66**	**15**	**6**
Female	3	15	13	10	2	0
Male	11	127	105	56	13	6
Civil Eng	**4**	**58**	**55**	**14**	**5**	**1**
Female	1	12	9	1	0	0
Male	3	46	46	13	5	0
Total	**47**	**477**	**410**	**164**	**48**	**19**

A t-test was conduced for each major by gender to see if differences existed. A data file was created for each major then t-test conducted by gender with coding as 0 for males and 1 for females. Results are shown in Tables on pages 116-120.

Table 58 indicates the results of a t-test for Mechanical engineering majors by gender related to time to completion of CBK. There is almost no difference in the mean or SD between male and female mechanical engineering majors.

Table 58
Descriptive Parameters Mechanical Engineering Students by Gender

	N	Mean	σ
Male	318	2.85	1.013
Female	43	2.84	1.022

Levene's Test for Equality for Mechanical engineering male and female students resulted in $F = .140$ and $p = 0.709$. Since there was no statistical significance with Levene's Test then equal variances are assumed. Results in Table 59 indicate no statistical significance ($t = 0.053$; $p = 0.958$) related to time to completion of CBK between male and female mechanical engineering students.

Table 59
t-test for Mechanical Engineering Students by Gender

			95% Confidence Interval of the Difference	
	t	Sig. (2-tailed)	Lower	Upper
Equal variances assumed	.053	.958	-0.315	0.333

Table 60 indicates the results of a t-test for Chemical Engineering majors by gender related to time to completion of CBK. Female Chemical engineers ($\mu = 2.47$; $\sigma = 0.94$ semesters) are completing CBK in less time than male Chemical Engineering students ($\mu = 2.61$; $\sigma = 1.018$ semesters).

Table 60
Descriptive Parameters Chemical Engineering Students by Gender

	N	Mean	σ
Male	139	2.61	1.018
Female	74	2.47	.940

Results in Table 61 indicate no statistical significance ($t = 0.971$; $p = 0.333$) relationship in time to completion of CBK between male and female Chemical Engineering students.

Table 61
t-test for Chemical Engineering Students by Gender

			95% Confidence Interval of the Difference	
	t	Sig. (2-tailed)	Lower	Upper
Equal variances assumed	.971	.333	-0.143	0.420

Table 62 indicates the results of a t-test for Civil Engineering majors by gender related to time to completion of CBK. Female Civil engineers ($\mu = 2.43$; $\sigma = 0.662$ semesters) are completing CBK in less time than male Chemical Engineering students ($\mu = 2.77$; $\sigma = 0.912$ semesters).

Table 62
Descriptive Parameters Civil Engineering Students by Gender

	N	Mean	σ
Male	114	2.77	0.912
Female	23	2.43	0.662

Levene's Test for Equality for Civil Engineering male and female students resulted in F = 1.306 and p = 0.255. Since there was no statistical significance with Levene's Test then equal variances are assumed. Results in Table 63 indicate no statistical significance (t =1.683; p= 0.095) related to time to completion of CBK between male and female Chemical Engineering students.

Table 63
t-test for Civil Engineering Students by Gender

			95% Confidence Interval of the Difference	
	t	**Sig. (2-tailed)**	**Lower**	**Upper**
Equal variances assumed	1.683	.095	-0.059	0.733

Table 64 indicates the results of a t-test for Computer Engineering majors by gender related to time to completion of CBK. Female Computer engineers ($\mu = 2.89$; $\sigma = 0.993$ semesters) are completing CBK in less time than male Chemical Engineering students ($\mu = 2.97$; 1.004 semesters).

Table 64
Descriptive Parameters Computer Engineering Students by Gender

	N	**Mean**	**σ**
Male	216	2.97	1.004
Female	35	2.89	0.993

Levene's Test for Equality for Computer Engineering male and female students resulted in F = 0.013 and p = 0.909. Since there was no statistical significance with Levene's Test then equal variances are assumed. Results in Table 65 indicate no statistical significance related to time to completion of CBK between male and female Computer Engineering students.

Table 65
t-test for Computer Engineering Students by Gender

			95% Confidence Interval of the Difference	
	t	**Sig. (2-tailed)**	**Lower**	**Upper**
Equal variances assumed	0.448	0.654	-0.278	0.442

Table 66 indicates the results of a t-test for Electrical Engineering majors by gender related to time to completion of CBK. Female Electrical engineers ($\mu = 2.47$; $\sigma = 0.819$ semesters) are completing CBK in less time than male Electrical Engineering students ($\mu = 2.77$; $\sigma = 0.965$ semesters).

Table 66
Descriptive Parameters Electrical Engineering Students by Gender

	N	**Mean**	**σ**
Male	173	2.77	0.965
Female	30	2.47	0.819

Levene's Test for Equality for Electrical Engineering male and female students resulted in F = 0.350 and p = 0.555. Since there was no statistical significance with

Levene's Test then equal variances are assumed. Results in Table 67 indicate no statistical significance related to time to completion of CBK between male and female Electrical Engineering students.

Table 67
t-test for Electrical Engineering Students by Gender

			95% Confidence Interval of the Difference	
	t	**Sig. (2-tailed)**	**Lower**	**Upper**
Equal variances assumed	1.647	.101	-0.061	0.677

Statistical significance was not found by gender for any of the five majors used in this study. However, the descriptive parameters indicate women finished CBK faster than males in all majors.

Major and Ethnicity

Table 68 indicates completion of CBK by major and ethnicity. A t-test was conduced for each major by ethnicity (minority or non-minority) to see if relationships existed. A data file was created for each major then t-test conducted by ethnicity with coding as 0 for non-minority and 1 for minority. Results are show in Tables on pages 122-126. If statistical significance was found then further analysis was conducted related to specific ethnic groups. Empty cells or subcategories without students in them (African American Computer Engineering majors taking 1, 5, or 6 semesters to complete CBK) do not impact statistical analysis because they are accounted for in the standard deviations.

Table 68
CBK Completion by Major and Ethnicity

	Semesters to Completion of CBK					
	1	**2**	**3**	**4**	**5**	**6**
Computer Eng	**6**	**80**	**110**	**36**	**12**	**7**
African Am.	0	6	6	1	0	0
Hispanic	0	1	12	3	4	1
White	6	59	81	25	6	6
Asian	0	14	11	7	2	0
Native Am	0	0	0	0	0	0
Electrical Eng	**5**	**94**	**70**	**21**	**11**	**2**
African Am.	0	0	2	3	0	1
Hispanic	0	5	3	0	0	0
White	5	81	61	18	7	1
Asian	0	8	4	0	3	0
Native Am	0	0	0	0	1	0
Chemical Eng	**18**	**103**	**57**	**27**	**5**	**3**
African Am.	0	0	3	1	0	0
Hispanic	2	3	3	3	1	0
White	12	91	49	20	4	2
Asian	4	9	2	3	0	1
Native Am	0	0	0	0	0	0
Mechanical Eng	**14**	**142**	**118**	**66**	**15**	**6**
African Am.	0	1	1	0	2	0
Hispanic	0	14	10	6	1	0
White	12	123	107	59	11	6
Asian	2	4	0	1	1	0
Native Am	0	0	0	0	0	0
Civil Eng	**4**	**58**	**55**	**14**	**5**	**1**
African Am.	0	0	2	0	1	0
Hispanic	0	3	6	3	0	0
White	4	54	46	11	4	1
Asian	0	0	1	0	0	0
Native Am	0	1	0	0	0	0
Total	**47**	**477**	**410**	**164**	**48**	**19**

Table 69 indicates the results of a t-test for Mechanical Engineering majors by ethnicity related to time to completion of CBK. Non-minority Mechanical engineers (μ

= 2.84 σ = 1.017 semesters) are completing CBK in less time than minority Mechanical Engineering (μ =2.91 σ = 0.98 semesters) students.

Table 69
Descriptive Parameters
Mechanical Engineering Students by Minority Status

	N	Mean	σ
Minority	35	2.91	0.98
Non-Minority	326	2.84	1.017

Levene's Test for Equality for Mechanical engineering male and female students resulted in F = .060 and p = 0.806. Since there was no statistical significance with Levene's Test then equal variances are assumed. Results in Table 70 indicate no statistical significance (t = -0.426; p = 0.670) related to time to completion of CBK between minority and non-minority mechanical engineering students.

Table 70
t-test for Mechanical Engineering Students by Minority Status

			95% Confidence Interval of the Difference	
	t	**Sig. (2-tailed)**	**Lower**	**Upper**
Equal variances assumed	-0.426	0.670	-.432	0.278

Table 71 indicates the results of a t-test for Chemical Engineering majors by minority or non-minority status related to time to completion of CBK. Non-minority

Chemical engineers ($\mu = 2.53$ $\sigma = 0.977$ semesters) are completing CBK in less time than minority Chemical Engineering students ($\mu = 2.94$ $\sigma = 1.124$ semesters).

Levene's Test for Equality for Chemical Engineering male and female students resulted in F = 0.091 and p = 0.763. Since there was no statistical significance with Levene's Test then equal variances are assumed.

Table 71
Descriptive Parameters Chemical Engineering Students Minority Status

	N	Mean	σ
Minority	16	2.94	1.124
Non-Minority	197	2.53	0.977

Results in Table 72 indicate no statistical significance (t = -1.575; p = .117) related to time to completion of CBK between minority and non-minority Chemical Engineering students.

Table 72
t-test for Chemical Engineering Students by Minority Status

			95% Confidence Interval of the Difference	
	t	Sig. (2-tailed)	Lower	Upper
Equal variances assumed	-1.575	0.117	-0.911	0.102

Table 73 indicates the results of a t-test for Civil Engineering majors by minority or non-minority status related to time to completion of CBK. Non-minority Civil engineers (μ = 2.67 σ = 0.879 semesters) are completing CBK in less time than minority Civil Engineering (μ =3.06 σ = 0.879 semesters) students.

Table 73
Descriptive Parameters Civil Engineering Students by Minority Status

	N	Mean	σ
Minority	16	3.06	0.854
Non-Minority	121	2.67	0.879

Levene's Test for Equality for Civil Engineering minority and non-minority students resulted in F = 0.664 and p = 0.417. Since there was no statistical significance with Levene's Test then equal variances are assumed. Results in Table 74 indicate no statistical significance (t =1.686; p= 0.094) related to time to completion of CBK between male and female Chemical Engineering students.

Table 74
t-test for Civil Engineering Students by Minority Status

			95% Confidence Interval of the Difference	
	t	Sig. (2-tailed)	Lower	Upper
Equal variances assumed	-1.686	.094	- .854	0.068

Table 75 indicates the results of a t-test for Computer Engineering majors by minority or non-minority status related to time to completion of CBK. Non-minority Computer engineers (μ = 2.91 σ = 0.944 semesters) are completing CBK in less time than minority Computer Engineering (μ =3.24 σ = 1.017 semesters) students.

Table 75
Descriptive Parameters Computer Engineering Students by Minority Status

	N	Mean	σ
Minority	34	3.24	1.017
Non-Minority	217	2.91	0.944

Levene's Test for Equality for Chemical Engineering minority and non-minority students resulted in F = 0.092 and p = 0.762. Since there was no statistical significance with Levene's Test then equal variances are assumed. Results in Table 76 indicate no statistical significance (t = -1.756; p = .080) related to time to completion of CBK between minority and non-minority Computer Engineering students.

Table 76
t-test for Computer Engineering Students by Minority Status

			95% Confidence Interval of the Difference	
	t	**Sig. (2-tailed)**	**Lower**	**Upper**
Equal variances assumed	-1.756	.080	-.685	0.039

Table 77 indicates the results of a t-test for Electrical Engineering majors by minority or non-minority status related to time to completion of CBK. Non-minority Electrical engineers (μ = 2.69 semesters) are completing CBK in less time than minority Electrical Engineering students (μ =3.20 semesters).

Table 77
Descriptive Parameters Electrical Engineering Students by Minority Status

	N	Mean	σ
Minority	15	3.20	1.207
Non-Minority	188	2.69	0.920

Levene's Test for Equality for Electrical Engineering minority and non-minority students resulted in F = 1.624 and p = 0.204. Since there was no statistical significance with Levene's Test, equal variances are assumed. Table 78 contains results indicating statistical significance was found in the relationships of time to CBK completion and minority status for electrical engineering majors; thereby, warranting further analysis.

Table 78
t-test for Electrical Engineering Students by Minority Status

			95% Confidence Interval of the Difference	
	t	Sig. (2-tailed)	Lower	Upper
Equal variances assumed	-2.011	.046*	-1.007	-0.010

* Statistical Significance at 0.05 level

Table 79 indicates results for the ANOVA conducted for Electrical Engineers by Ethnicity due to the results indicated in Table 76 showing statistical significance. R^2 was 0.091 with adjusted R^2 of 0.073 indicating that ethnicity accounted for approximately 9% (7% adjusted) in time to completion of CBK for electrical engineering students. Statistical significance was found at the 0.01 level (p = 0.001).

Table 79
ANOVA[b] for Electrical Engineering and Ethnicity

	DF	SS	MS	F	Sig.
Regression	4	16.617	4.154	4.971	.001[a**]
Residual	198	165.481	0.836		
Total	202	182.099			

a Predictors: (Constant), Hispanic, African American, Asian, White
b Dependent variable: Semester to CBK completion
** Statistical Significance was found at 0.01 level

Table 80 indicates the beta weights (β) and coefficients for the four ethnicities of Electrical Engineering majors. Statistical significance was found at the 0.05 level for Asian students (0.025) and White (p= 0.012) students, and at the 0.01 level for and Hispanic (p = 0.007) students. This indicates that being Asian, White or Hispanic as an Electrical Engineering major has a relationship to time to completion of CBK.

Table 80
Coefficients[a] Major

	Unstandardized Coefficients		Standardized Coefficients		
	B	**Std. Error**	**Beta**	**t**	**Sig.**
(Constant)	5.000	.914		5.469	.000
African Am	-1.000	.987	-.170	-1.013	.312
Asian	-2.133	.944	-.589	-2.259	*.025
White	-2.324	.917	-.871	-2.534	*.012
Hispanic	-2.625	.970	-.539	-1.707	**.007

a Dependent variable: Semester to CBK completion
* Statistical Significance at 0.05 level
** Statistical Significance at the 0.01 level

Major by UFN

Table 81 indicates the semesters to completion of CBK by Major and UFN.

Table 81
Number Completing CBK by Major and Unmet Financial Need

	Semesters to Completion of CBK					
	1	**2**	**3**	**4**	**5**	**6**
Computer Eng	**6**	**80**	**110**	**36**	**12**	**7**
UFN	0	13	24	10	7	1
No UFN	6	67	86	26	5	6
Electrical Eng	**5**	**94**	**70**	**21**	**11**	**2**
UFN	0	14	15	6	3	0
No UFN	5	80	55	15	8	2
Chemical Eng	**18**	**103**	**57**	**27**	**5**	**3**
UFN	4	15	16	8	2	2
No UFN	14	88	41	19	3	1
Mechanical Eng	**14**	**142**	**118**	**66**	**15**	**6**
UFN	4	23	22	15	4	0
No UFN	12	119	96	51	11	6
Civil Eng	**4**	**58**	**55**	**14**	**5**	**1**
UFN	0	11	16	3	2	0
No UFN	4	47	39	11	3	1
Total	**47**	**477**	**410**	**164**	**48**	**19**

Table 82 indicates results of a one-way ANOVA for major by unmet financial need (UFN). Since statistical significance was found, subsequent t-tests were conducted for each major related to UFN.

Table 82
ANOVA for Major by UFN

	DF	SS	MS	F	Sig.
Regression	5	32.457	6.491	6.814	.000[a]
Residual	1159	1104.165	.953		
Total	1164	1136.621			

a. Dependent variable: Semester to CBK completion

Table 83 indicates the results of a t-test for Mechanical engineering majors by UFN related to time to completion of CBK. Mechanical engineering students with no UFN (μ = 2.84 semesters) take less time to complete CBK than do those with UFN (μ = 2.88 semesters). There is almost no difference in the variance of Mechanical engineering students with or without UFN.

Table 83
Descriptive Parameters Mechanical Engineering Students and UFN

	N	Mean	σ
UFN	68	2.88	1.015
No UFN	293	2.84	1.014

Levene's Test for Equality for Mechanical engineering students and UFN resulted in F = .028 and p = 0.867. Since there was no statistical significance with Levene's Test then equal variances are assumed. Results in Table 84 indicate no statistical significance (t = -0.338; p = 0.735) related to time to completion of CBK between UFN and mechanical engineering students.

Table 84
t-test for Mechanical Engineering Students and UFN

			95% Confidence Interval of the Difference	
	t	Sig. (2-tailed)	Lower	Upper
Equal variances assumed	-.338	.735	-.315	.222

Table 85 indicates the results of a t-test for Chemical Engineering majors and UFN related to time to completion of CBK. Chemical engineering students with no UFN (μ = 2.47 semesters) take less time to complete CBK than do those with UFN (μ = 2.89 semesters). The variance in time to completion of CBK is 1.184 for Chemical engineering students with UFN and .912 for those with no UFN.

Table 85
Descriptive Parameters Chemical Engineering Students and UFN

	N	Mean	σ
UFN	47	2.89	1.184
No UFN	166	2.47	.912

Levene's Test for Equality for Chemical Engineering students and UFN resulted in F = 2.308 and p = 0.130. Since there was no statistical significance with Levene's Test then equal variances are assumed. Results in Table 86 indicate statistical significance at the 0.01 level (t = -2.622; p = .009) for Chemical engineering students UFN related to time to completion of CBK between Chemical Engineering students.

Table 86
t-test for Chemical Engineering Students and UFN

			95% Confidence Interval of the Difference	
	t	Sig. (2-tailed)	Lower	Upper
Equal variances assumed	-2.622	.009**	-.742	-.105

**Statically significance at the 0.01 level

Table 87 indicates the results of a t-test for Civil Engineering majors and UFN related to time to completion of CBK. Civil engineering students with no UFN (μ = 2.67 semesters) take less time to complete CBK than do those with UFN (μ = 2.88 semesters). The variance in time to completion of CBK is 0.833 for Civil Engineering students with UFN and 0.895 for those with no UFN.

Table 87
Descriptive Parameters Civil Engineering Students and UFN

	N	Mean	σ
UFN	32	2.88	.833
No UFN	105	2.67	.895

Levene's Test for Equality for Civil Engineering minority and non-minority students resulted in F = -1.294 and p = 0.257. Since there was no statistical significance with Levene's Test then equal variances are assumed. Results in Table 88 indicate no statistical significance (t = -1.171; p= 0.244) for Civil engineering majors and UFN related to time to completion of CBK.

Table 88
t-test for Civil Engineering Students and UFN

			95% Confidence Interval of the Difference	
	t	Sig. (2-tailed)	Lower	Upper
Equal variances assumed	-1.171	.244	-.560	.144

Table 89 indicates results of a t-test for Computer Engineering majors by minority or non-minority status related to time to completion of CBK. Computer Engineering students with no UFN (μ = 2.87 semesters) take less time to complete CBK than do those with UFN (μ = 3.25 semesters). The variance in time to completion of CBK is 1.022 for Computer Engineering students with UFN and 0.981 for those with no UFN.

Table 89
Descriptive Parameters Computer Engineering Students and UFN

	N	Mean	σ
UFN	55	3.25	1.022
No UFN	196	2.87	.981

Levene's Test for Equality for Chemical Engineering minority and non-minority students resulted in F = 0.1.067 and p = 0.303. Since there was no statistical significance with Levene's Test then equal variances are assumed. Results in Table 90 indicate statistical significance at the 0.05 level (t = -2.528; p = .012) related to time to completion of CBK and UFN of Computer Engineering students.

Table 90
t-test for Computer Engineering Students by UFN

			95% Confidence Interval of the Difference	
	t	Sig. (2-tailed)	Lower	Upper
Equal variances assumed	-2.528	.012*	-.680	-.084

Statistical Significance found at the 0.05 level

Table 91 indicates the results of a t-test for Electrical Engineering majors and UFN related to time to completion of CBK. Electrical Engineering students with no UFN (μ = 2.68 semesters) take less time to complete CBK than do those with UFN (μ = 2.95 semesters). The variance in time to completion of CBK is 0.928 for Chemical Engineering students with UFN and with no UFN.

Table 91
Descriptive Parameters Electrical Engineering Students and UFN

	N	Mean	σ
UFN	38	2.95	.928
No UFN	165	2.68	.950

Levene's Test for Equality for Electrical Engineering and UFN resulted in F = .360 and p = 0.549. Since there was no statistical significance with Levene's Test then equal variances are assumed. Results in Table 92 indicate no statistical significance related to time to completion of CBK by Electrical Engineering majors and UFN.

Table 92
t-test for Electrical Engineering Students and UFN

			95% Confidence Interval of the Difference	
	t	Sig. (2-tailed)	Lower	Upper
Equal variances assumed	-1.578	.116	-.604	.067

Findings indicate that enrollment for the five engineering majors align closely with national enrollment figures during the same period as this study. Table 93 presents a summary of the findings related to the variables studied and major. Chemical engineering majors had the shortest time to completion of CBK with a mean of 2.56 semesters and Computer Engineering majors took the longest to complete CBK with a mean of 2.96 semesters. Variances range from σ = 0.88 for civil engineering majors to σ = 1.01 for mechanical engineering majors.

Table 93
Descriptive Parameters for Semesters to Completion of CBK by Major

	Civil		**Chemical**		**Computer**		**Electrical**		**Mechanical**	
	Mean	σ	Mean	σ	Mean	σ	Mean	σ	Mean	σ
Male	2.77	0.912	2.61	1.018	2.97	1.004	2.77	0.965	2.85	1.013
Female	2.43	0.662	2.47	0.940	2.89	0.993	2.47	0.819	2.84	1.022
	p = 0.095		p = 0.333		p = 0.654		p = 0.101		p= 0.958	
Minority	3.06	0.854	2.94	1.124	3.24	1.017	3.20	1.207	2.91	0.98
Non-Minority	2.67	0.879	2.53	0.977	2.91	0.944	2.69	0.920	2.84	1.017
	p = 0.094		p = 0.117		p = 0.080		p= 0.046*		p = 0.670	
UNF	2.88	0.833	2.89	1.184	3.25	1.022	2.95	0.928	2.88	1.015
No UFN	2.67	0.895	2.47	0.912	2.87	.0981	2.68	0.950	2.84	1.014
	p = 0.244		p = 0.009**		p = 0.012*		p = 0.116		p = 0.735	

* Statistical Significance at 0.05 level   ** Statistical Significance at 0.01 level

Analysis by gender indicates that in every major females are completing CBK faster than males. However, none of the results were found to be statistically significant. Parameters associated with major by ethnicity indicated that in every major minority students took longer on average to complete CBK than did non-minority students.

Electrical Engineering was the only major found to have statistical significance at the 0.05 level (p = .046) between major and ethnicity. Within Electrical Engineering majors, statistical significance was found at the 0.05 level for Asian (p = 0.025) and White (p = 0.012) students, and at the 0.01 level for Hispanic students (p = 0.007).

Students with UFN were the larger of the two groups in each of the five majors in this study. Results indicate that those with no UFN are completing CBK in less time than students not having UFN in all of the five majors, with the largest difference in means being Computer Engineering majors (UFN = 3.25 semesters vs. No UFN = 2.87 semesters). Statistical significance was found for Chemical Engineering students at the 0.01 level (p = 0.009) for Computer Engineering students at the 0.05 level (p = 0.012)

Research Questions 5 (RQ5) and 6 (RQ6) contain continuous data and therefore analysis using Pearson's r was conducted for these two study questions.

Question 5

What is the relationship between cumulative grade point average at time of progression to upper level status and time to completion of CBK?

For all students in the population, Table 94 indicates that the mean CGPA at time of progression to upper level status was 3.0191 with a standard deviation (σ) of 0.53283.

Table 94
Frequency, Mean and Standard Deviation (σ)
for Time to Completion by Cumulative GPA

	N	Minimum	Maximum	Mean	σ
CGPA at time of CBK completion	1165	1.05	4.0	3.0191	0.53283

Figure 4 indicates the mean cumulative grade point average (CGPA) by semester of time to completion of CBK. This figure shows that students who on average have a higher CGPA are completing CBK in less time than those with lower CGPA, with the exception of students completing CBK in five semesters.

Figure 4: CGPA at Time of Completion of CBK

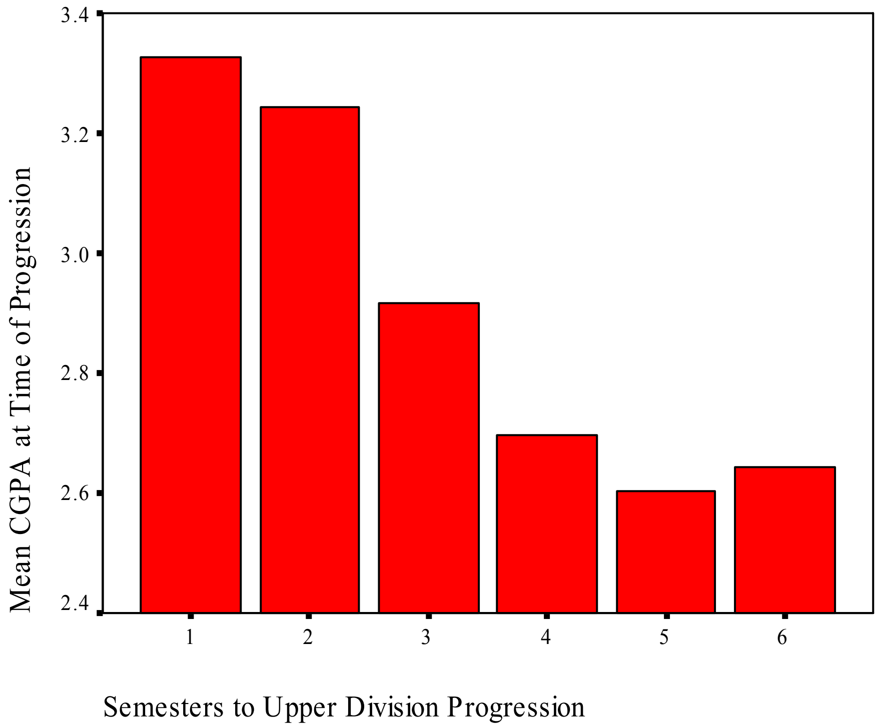


Table 95 indicates results of the relationship of CGPA to time to completion are statistically significant at the higher level of 0.01, with a strong correlation (r = -0.408, p = $1.2*10^{-22}$). Results indicate almost no probability (p = $1.2*10^{-22}$) that the statistical result was obtained by chance and the correlation for the relationship of CGPA to time to completion is very strong. The negative r indicates that the higher the CGPA the less number of semesters a student takes to completion of CBK.

Table 95
Multiple Regression and p values by CGPA

	Pearson's r	**p value**	**Significance**
CGPA	-0.408	$1.2*10^{-22}$	0.01**

** Statistical Significance at the 0.01 level

The variable CGPA is responsible for over 16% (R^2, 0.167; adjusted R^2 of 0.166) of the total 19% effect size (R^2) of all the variables in this study related to time to completion of CBK. The beta weight (β) was 0.404 with an effect size of R^2 of 0.167 and adjusted R^2 of 0.166.

Since CGPA was found to be statistically significant, further analyses were conducted. Table 95 contains descriptive parameters for CGPA at time of CBK completion by gender, ethnicity, UFN, and student major. The minimum CGPA across all categories was less than a 2.00 CGPA, ranging from a low of 1.05 for a Mechanical Engineering major to 1.92 for an Electrical Engineering major. The standard deviations for all but two subcategories in Table 95 were between a $\sigma > 0.5$ and < 0.6. The two subcategories having $\sigma < 0.5$, were African American students ($\sigma = 0.4736$) and students with UFN ($\sigma = 0.4910$). The only subgroup that did not have a maximum CGPA at time of CBK completion of 4.0 was African Americans with the maximum CGPA of 3.87.

For gender, Table 96 indicates mean CGPA at time of progression to upper division or completion of CBK for males was 3.0028 with a σ of 0.5279 and for females a mean CGPA of 3.0950 and σ of 0.5503. By ethnic group, there were no African American students who had a 4.00 CGPA and the lowest CGPA was for a white student. The lowest mean CGPA was 2.453 for Hispanic students with the highest mean of 3.0519 for White students. Minority students (African American $\mu = 2.657$, $\sigma = 0.4736$; and Hispanic $\mu = 2.4530$, $\sigma = 0.5805$) had lower mean CGPA than non-minority (White $\mu = 3.0519$ $\sigma = 0.5225$, and Asian $\mu = 2.9403$, $\sigma = 0.5476$) students did.

Table 96
CGPA at CBK Completion by Gender, Ethnicity, UFN, and Major

	Minimum	Maximum	Mean	Std. Deviation
Gender				
Male	1.05	4.0	3.0028	0.5279
Female	1.60	4.0	3.0950	0.5503
Ethnicity				
African Am	1.75	3.87	2.6577	0.4736
Hispanic	1.74	4.00	2.4630	0.5805
White	1.05	4.00	3.0519	0.5225
Asian	1.43	4.00	2.9403	0.5476
Financial Need				
No UFN	1.05	4.00	3.0409	0.5413
UFN	1.52	4.00	2.9348	0.4910
Major				
Computer	1.60	4.00	3.0569	0.5177
Electrical	1.92	4.00	3.0409	0.5185
Chemical	1.79	4.00	3.1233	0.5172
Mechanical	1.05	4.00	2.9799	0.5522
Civil	1.74	4.00	2.8584	0.5133

Students without UFN have a mean CGPA of slightly higher (μ =3.0409, σ = 0.5413) than those with UFN (μ = 2.9348, σ = 0.4910). Civil and Mechanical Engineering majors mean CGPA was lower than a 3.0 while Computer, Electrical and Chemical engineering students have slightly higher mean CGPAs than 3.0.

Table 97 shows results of statistical correlations related to time to CBK completion by gender, ethnicity, UFN, and major. All correlations for categories by gender, ethnicity, UFN, and major had negative Pearson's r, indicating that on average, the higher a student's CGPA, the fewer semesters needed to complete CBK, also related to Figure 4. These correlations were statistically significant at the 0.01 level for every subgroup except for African American (p = 0.108).

Table 97
Correlations for CGPA for CBK Completion
by Gender, Ethnicity, UFN, and Major

	Pearson R	P value
Gender		
Male	-0.404	1.798552572438e-022**
Female	-0.414	6.966729669084e-010**
Ethnicity		
African American	**-0.299**	**0.108**
Hispanic	-0.489	2.302934943482e-006**
White	-0.408	1.749272002518e-022**
Asian	-0.292	0.010**
Financial Need		
No unmet need	-0.407	1.957435268415e-022**
Unmet need	-0.391	3.464007987527e-010**
Major		
Computer	-0.303	1.039433389052e-006**
Electrical	-0.055	2.423847434719e-014**
Chemical	-0.493	1.601806126336e-014**
Mechanical	-0.440	1.43293831096e-018**
Civil	-0.264	0.002**

**Statically significance at 0.01 level

The College requires a minimum of 3.0 in CBK for students to advance to upper level, and the lowest cumulative grade point acceptable to any of the five majors in this study is for civil engineering at 2.5 CGPA. The overall CGPA required for progression to upper division status for the five majors in this study are: 3.125- Computer Engineering; 3.00-Chemical Engineering; 2.75-Electrical and Mechanical Engineering; 2.50-Civil Engineering. 196 students had less than a 2.50 CGPA: 26 Chemical Engineering, 34 Civil Engineering, 34 Computer Engineering; 32 Electrical Engineering; and 70 Mechanical Engineering. The data in Table 98 indicate that the minimum CGPA of any student completing CBK is 1.05, which is inconsistent with College policy.

Furthermore, university and College policy at TAMU indicate that students below 2.00 are not in good standing and normally are not allowed to progress to upper division status or remain in a major. Table 97 was created to see if any patterns might exist related to students in this study with less than a 2.0 CGPA yet who advanced to upper division status and completed CBK. No particular trend appears evident as all majors, gender, ethnicity and transfer or non-transfer hours are represented though there appears to be a slightly larger number of Mechanical Engineering students present in this group.

Discussion with the Engineering Academic Program Office (EAPO) at TAMU indicated that faculty advisors in the various departments had the latitude to waive a student who fell below the required CGPA for moving to upper level status. Therefore, it is highly likely that these students may have been exceptions which the five departmental advisors waived the CGPA requirement and at that time deemed worthwhile to provide with an opportunity to continue on to upper division coursework. Note that all five majors are represented in Table 98 and many students have transfer hours. It should not be ruled out that there could be the possibility of error or oddity in the data set pulled. However, despite either possibility of waiver by engineering departmental advisors or peculiarity in the data, the strength of the relationship and statistical analysis would be difficult to discount. CGPA is the strongest determining factor in this study for completion of CBK and progression to upper level status by the five majors studied.

Table 98
Students in study with CGPA of below 2.0 at time of CBK Completion by Major, Gender, Ethnicity and Transfer hours

GPA	Major	Gender	Ethnicity	Transfer Hours	Semesters to Progression
1.05	Mechanical	Male	White	6	2
1.43	Mechanical	Male	Asian	0	1
1.52	Mechanical	Male	White	22	2
1.60	Computer	Female	White	12	5
1.74	Civil	Female	Hispanic	24	3
1.75	Computer	Male	White	9	3
1.75	Civil	Female	African American	0	3
1.79	Chemical	Female	Hispanic	0	4
1.81	Civil	Male	Hispanic	33	4
1.84	Civil	Male	White	0	2
1.84	Mechanical	Male	White	11	6
1.85	Mechanical	Male	Hispanic	27	4
1.87	Mechanical	Male	White	0	2
1.89	Chemical	Male	Asian	17	4
1.92	Electrical	Male	White	0	4
1.92	Mechanical	Male	Hispanic	30	4
1.94	Mechanical	Male	White	3	6
1.94	Civil	Male	White	0	3
1.96	Mechanical	Male	White	9	4
1.97	Mechanical	Male	White	0	3
1.97	Mechanical	Male	White	14	2
1.98	Mechanical	Female	White	6	4
1.98	Electrical	Male	White	22	4
1.98	Computer	Male	Asian	6	4

Question 6

What is the relationship between the total number of credit hours transferred at time of enrollment at TAMU in engineering and time to completion of CBK?

For this study credit hours transferred includes any credit given a student at time of enrollment from another institution of higher education or credits accepted by TAMU such as the Advanced Placement (AP) or College Level Examination Program (CLEP).

Figure 5 charts the mean number of transfer hours by semesters for CBK

Figure 5: Mean Total Transfer Hours by Semesters to Complete CBK

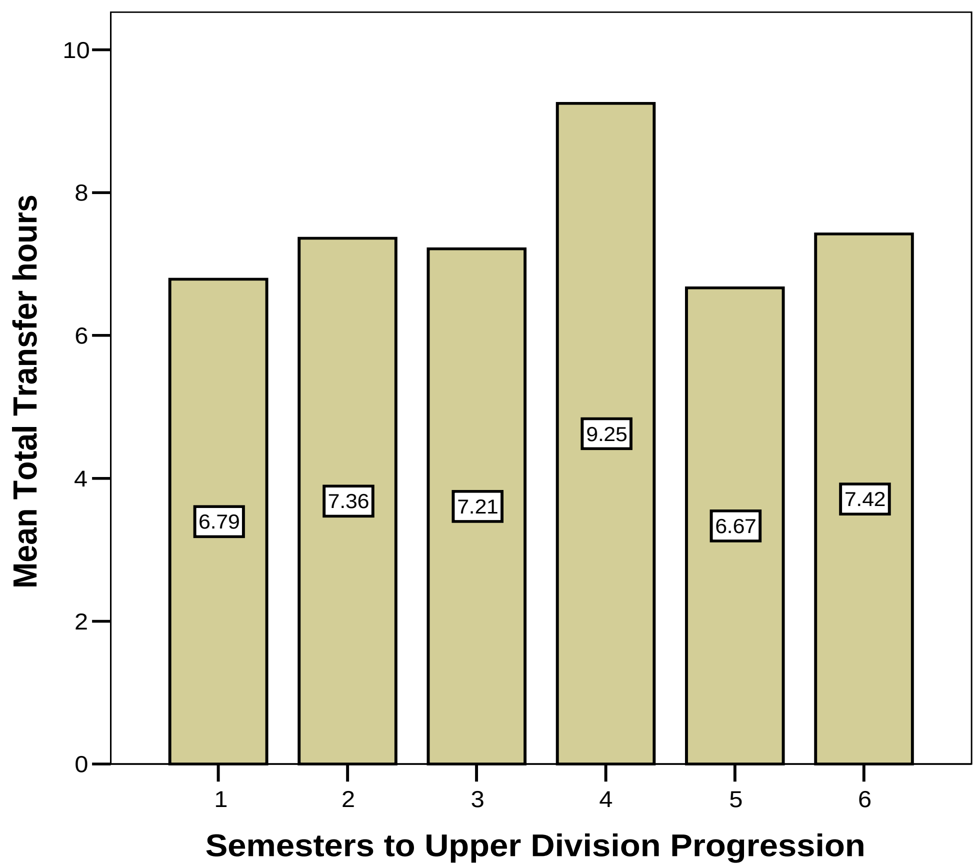


Table 99 indicates the number of students in the study who obtained transfer hour credit. Two-thirds of the students in this study transferred in 3 or more hours, with 393 or 33.7% enrolling with zero credit hours (Table 99). In this study, of those transferring in hours, 708 (60.8%) had between 3 and 24 hours, with the remaining 64 students (5.4%) transferring between 25 and 110 hours. 341 students transferred or received AP or other such credit for between 3-6 hours; 196 students had 7-12 hours, and 171 students have 13-24 hours of credit transferred.

Table 99
Descriptive Statistics by Transfer Hours

	N	Minimum	Maximum	Mean	σ
Total Transfer hours	1165	0	110	7.52	10.58

Table 100 indicates descriptive parameters for students in the study related to total transfer hours. The number of transfer hours ranged from zero (0) to 110 with a mean of 7.52 (σ = 10.58) and a median of 4.00 hours and standard deviation of 10.58 hours.

Table 100
Frequency Table for Students by Transfer Hours

Total Transfer hours

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	393	33.7	33.7	33.7
	3	182	15.6	15.6	49.4
	4	35	3.0	3.0	52.4
	6	124	10.6	10.6	63.0
	7	35	3.0	3.0	66.0
	8	15	1.3	1.3	67.3
	9	52	4.5	4.5	71.8
	10	19	1.6	1.6	73.4
	11	27	2.3	2.3	75.7
	12	48	4.1	4.1	79.8
	13	19	1.6	1.6	81.5
	14	25	2.1	2.1	83.6
	15	22	1.9	1.9	85.5
	16	13	1.1	1.1	86.6
	17	13	1.1	1.1	87.7
	18	15	1.3	1.3	89.0
	19	5	.4	.4	89.4
	20	15	1.3	1.3	90.7
	21	18	1.5	1.5	92.3
	22	13	1.1	1.1	93.4
	23	5	.4	.4	93.8
	24	8	.7	.7	94.5
	25	4	.3	.3	94.8
	26	5	.4	.4	95.3
	27	5	.4	.4	95.7
	28	4	.3	.3	96.1
	29	3	.3	.3	96.3
	30	8	.7	.7	97.0
	31	5	.4	.4	97.4
	32	1	.1	.1	97.5
	33	1	.1	.1	97.6
	34	3	.3	.3	97.9
	35	3	.3	.3	98.1
	36	1	.1	.1	98.2
	37	1	.1	.1	98.3
	38	2	.2	.2	98.5
	39	1	.1	.1	98.5
	40	3	.3	.3	98.8
	41	3	.3	.3	99.1
	42	1	.1	.1	99.1
	44	1	.1	.1	99.2
	48	1	.1	.1	99.3
	49	1	.1	.1	99.4
	50	1	.1	.1	99.5
	70	1	.1	.1	99.6
	84	1	.1	.1	99.7
	87	1	.1	.1	99.7
	93	1	.1	.1	99.8
	109	1	.1	.1	99.9
	110	1	.1	.1	100.0
	Total	1165	100.0	100.0	

94% of students in this study are transferring in less than 24 hours. The average number of hours transferred for this study is just over 7 hours. There is a possibility of these hours being from AP credit or hours transferred from credit earned through concurrent enrollment during high school by high achieving students rather than traditional transfer students. Students transferring in more hours appear to take longer to complete CBK. The majority of students in this study completed CBK by 3 semesters, while students transferring in on average approximately 9.4 hours (Figure 5), took longer (4 semesters) to complete CBK.

The beta weight (β) for this research question was 0.020 with an effect size or R^2 of 0.001 and adjusted R^2 of -0.0000689. This shows that transfer hours account for less than 2% of the relationship of the variables in this study to completion of CBK, which is progression to upper division status in engineering.

Table 101 indicates results of the Pearson r with no statistical significance found for this variable with error due to results being obtain by chance being high ($p = 0.338$) and little relationship to CBK completion ($r = 0.028$).

Table 101
Multiple Regression Results and p Value for Transfer Hours

	Pearson's r	p value	Significance
Total Transfer hours	0.028	0.338	no

Even though the variable transfer hours was not statistically significant, the data indicating that students taking four semesters had the largest mean number of transfer hours was interesting enough to merit further analysis.

Transfer Hours by Gender, Ethnicity, UFN and Major

Table 102 shows the relationships for transfer hour to CBK completion by gender, ethnicity, UFN, and major. There was no statistical significance, as expressed by p values all < 0.05 level, for transfer hours relevant to gender, ethnicity, UFN, or major, and that correlations for Hispanic students transferring in hours (r 0.211, p 0.054) is the only quasi-relevant relationship to CBK completion.

Table 102
Correlations for Transfer Hours to CBK by Gender, Ethnicity, UFN, and Major

	Pearson R	p value
Gender		
Male	.021	.521
Female	.048	.490
Ethnicity		
African Am	-.094	.623
Hispanic	.211	.054
White	.031	.339
Asian	-.088	.445
Financial Need		
No UFN	.026	.430
UFN	.039	.543
Major		
Computer	-.041	.826
Electrical	.011	.875
Chemical	.010	.890
Mechanical	.041	.436
Civil	.111	.196

The transfer credit hours variable contributes 0.1 of 1% to the total 19% effect size (R^2) of all the variables in this study related to time to completion of CBK. This finding was of interest as the researcher felt transfer hours would have a relationship to completion of CBK and that perhaps a student coming in with more hours might complete CBK faster. This is not the case and no statistically significant relationship of transfer hours or credits transferred in to completion of CBK exists.

There were only two categories where the p value was not substantially large. One was Hispanic students transferring in hours who were the only group to show any type of relationship to CBK completion ($r = 0.211$) and though not statistically significant, it barely missed significant at the 0.05 level ($p = 0.054$). The next lowest p value of any category related to transfer hours to time to completion of CBK (Table 98) was Civil engineering (p value of 0.196). All other p values were substantially large, indicating a high probability that results were obtained by chance.

Pearson r found no statistical significance for this variable related to time to completion of CBK with error due to results being obtain by chance being high ($p = 0.338$) and little relationship to CBK completion ($r = 0.028$).

Interactions

Based on review of the literature, this study also examined interaction effects for three variables: gender, underrepresented minority status, and unmet financial need. Two newly released national reports indicate that first-generation students in postsecondary education are most likely to be African American (Black) or Hispanic and from low income families (Chen & Carroll, 2005), and that Hispanics receive the lowest financial aid award of any ethnic group (Santiago & Cunningham, 2005).

Table 103 indicates the Univariate Analysis of Variance results for interactions among the three independent variables and time to progression to upper division status by completion of CBK. The statistical test used in the ANOVA is an "F-statistic" which is a result of taking the ratio of two variance measures. The MS is computed by dividing the row's df (degrees of freedom) into its SS where the total df being equal to one less than the number of subjects used in the study. Calculated values are presented in the F and p columns (Huck, 2000), with the negative or positive designation being due to the formula.

Table 103
Analysis of Variance: Gender, Minority Status, and Unmet Financial Need

Tests of Between-Subjects Effects

Dependent Variable: Semesters to Upper Division Progression

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	29.120[a]	7	4.160	4.346	.000
Intercept	2288.735	1	2288.735	2391.029	.000
gender	2.907	1	2.907	3.037	.082
unmetfin	3.540	1	3.540	3.698	.055
ethnic	6.980	1	6.980	7.292	.007
gender * unmetfin	.986	1	.986	1.030	.310
gender * ethnic	.121	1	.121	.127	.722
unmetfin * ethnic	.523	1	.523	.547	.460
gender * unmetfin * ethnic	.672	1	.672	.702	.402
Error	1107.501	1157	.957		
Total	10153.000	1165			
Corrected Total	1136.621	1164			

a. R Squared = .026 (Adjusted R Squared = .020)

Huck (2000) indicates that each of the Fs addresses a different null hypothesis. The df_{total} allows determination of how many individually were involved in the study. The df values for the main effect rows of the table indicate two levels in each factor.

In Table 103, the first four Fs are concerned with the study's main effects or the fours sets of main effect means, or variance. For instance the main effect of gender (G) related to time to completion of CBK. The remaining Fs in the table deal with the interactions between the various factors listed in each source box. In this case there are four main effects for ethnicity, as African American and Hispanic are broken out for the category underrepresented minorities to see if interactions exist.

Table 103 shows that p values of the two-way and three-way interactions indicate no significance at the .01 or .05 levels, indicating high probability of results being attributed to chance. The Error category is also termed "within groups" or "residual" (Huck, 2000).

The ANOVA with the dependent variable of completion of CBK yielded only one statistically significant result which was for the main effect of ethnicity at the 0.01 level ($F = 7.292$; $p = 0.007$). No statistical significance was found for the main effects gender ($F = 3.037$; $p > 0.05$ level) or UFN ($F = 1.030$; $p = 0.055$), or for interactions effects of: Gender * UFN ($F = 1.030$; $p = 0.310$); Gender * ethnic ($F = 0.547$; $p = 0.450$); or gender * UFN*ethnicity ($F = 0.702$; $p = 0.402$)

Therefore, interactions were not statistically significant, but ethnicity (refer also to Q2) did have a relationship to time to completion of CBK with only a very slight possibility the results were obtained by chance ($p = 0.007$).

CHAPTER V

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

The principle purpose of the study was to find if relationship of selected factors exist with regard to time to completion of the Core Body of Knowledge (CBK) for engineering majors at Texas A&M University. It should be noted that since this study included the entire population completing CBK and progressing to upper division status for the 1998 and 1999 Cohorts, that descriptive parameters showing substantial differences or trends will be critical factors of the discussion. Key findings of the study include:

Findings

- Gender was statistically significant ($p = 0.008$) and indicates females are taking less time to complete CBK than males
- Minority students are taking slightly longer (statistically significantly $p = 0.001$) to complete CBK than non-minorities, with African Americans taking the longest period of time to complete CBK (μ 3.23 $p = 0.011$)
- Unmet financial need (UFN) has a statistically significant relationship to completion of CBK at the 0.01 level ($p = 0.001$), with it taking longer for those having UFN to complete CBK than those with no UFN

- Of the five majors in this study, Computer Engineering was the only one with statistical significant relationship in time to completion of CBK ($p = 0.021$) with these students taking longer to complete CBK. Minority status for Electrical Engineering majors in this study had a statistical significance ($p = 0.046$) with minorities taking longer to complete CBK ($\mu = 3.20$ versus 2.69 for non-minority)
- Cumulative grade point average (CGPA) has statistical significance ($p < 0.01$) and a strong relationship (r -0.408) in time to completion of CBK. CGPA contributes the highest percent (R^2 of 16.7%) to the total 19% overall effect size of all the independent variables in this study. The negative indicates the higher the CGPA the less time needed to complete CBK.
- Though two-thirds of the students in this study transferred in 3 or more hours, statistical significance ($p = 0.338$) was not found for transfer credits related to time to completion of CBK
- Interactions associated with gender, minority status and unmet financial need were not statistically significant at either the 0.05 or 0.01 levels for time to completion of CBK.

Conclusions

Conclusions derived from the findings are listed below. In this study, all tests of significance were two-tailed and non-directional since this research was exploratory and not, “based on theoretical consideration or previous research” (Huck, 2000).

- Analysis of descriptive parameters indicates that females are taking less time than males to complete CBK in all of the majors. Conclusions can be that females across the college are entering better prepared for the foundational engineering CBK courses, which aligns with national findings, or that support programs the College may have had in place for females are highly effective.
- Minority engineering students take a statistically significant longer time to complete CBK as compared to non-minority students. A review of descriptive parameters for the entire population of all students completing CBK indicates substantial disparities between mean time to completion times for minority versus non-minority students. There may be a potential disparate impact attributed to the requirement of set GPAs for progression that cause minority students to complete CBK but take longer to do so. National findings indicate minority students come to engineering programs less prepared than their non-minority counterparts. With this being known and diversity being a focused recruitment effort of TAMU at present, it may benefit the College to address these findings to ensure broader success of underrepresented minority students accepted to TAMU.
- Having UFN statistically relates to and increases the time necessary to complete CBK, and minority students with UFN taking longer to complete CBK than non-minority students with UFN, which may be attributed to a greater need to work while enrolled in college by those with UFN.

- Computer engineering majors had a statistical relationship to time to completion of CBK, and Hispanic Electrical Engineers took longer to complete CBK with a statistically significant difference at the 0.01 level (p= 0.007). Departments appear to be a substantial factor in discrepancies between mean times to completion of CBK by gender, ethnicity and UFN. This has a potential relationship to the fact that different departments require different CGPAs in order to advance to upper division status. In the 1998 and 1999 cohorts Computer Science had the highest requirement (3.125 CGPA) of the five major studied.
- Cumulative Grade point average (CGPA) had the most statistically significant relationship to time to completion of CBK of all variables in this study, and indicates that the higher the CGPA set by a department for a specific major lengthens the time needed to complete CBK and progress to upper division status
- The number of transfer hours does not have a statistically significant relationship to completion of CBK but descriptive parameters, particularly related to students transferring in more than 9 hours and taking longer to complete CBK, and may contradict existing research that over 15 transfer hours increases chances of graduation, and indicates that certain mechanisms may not be in place within the College to appropriately recruit or advise transfer students.
- Two and three-way interactions of gender, minority status, and unmet financial need do not have a statistically significant relationship in time to completion of CBK beyond those accounted for by the main effects. Main effects state the

relationships between each variable and their time to completion of CBK. There is no additional variance accounted for by interactions among the variables, such as Hispanic females or African Americans with UFN.

Recommendations for Practice

- Focus on enhancing recruitment and retention efforts for high achieving women engineering students and continuing any enhancement programs in existence for women students
- Implement or revise targeted programs for underrepresented minorities to provide support needed to reduce time currently taking to completion of CBK. The continued focus on diversity by the College and TAMU suggests a need for minority student academic support programs as well as program for K-12 teacher improvement to better prepare students for engineering coursework and for counselors to encourage students to take advanced math and science preparatory courses.
- Continue or establish efforts for financial support of students having UFN and due to these findings being during the *Hopwood* findings, efforts need to be made to fully reinstate minority student scholarships in large enough amounts to displace the UFN factor
- Implement academic support programs for students with unmet financial need who are taking longer to complete CBK

- Departments should be encouraged to examine their disaggregated data from this study to define needs and establish mechanisms to improve the time to completion of CBK for all subgroups within their majors and College administrators should review for implications of disparate impact related to minority students specifically and under-prepared students in general of which the institution is accepting.
- CGPA has a relationship to time to complete CBK and progression to upper level division status. Departments should review mechanism to support students accepted to the college and consider the impact of additional time for minority students as having potential for disparate impact based on higher CGPA requirements.
- Departments and the College should also review details of CBK and non-CBK courses since the CGPA requirement includes grades for all coursework. Students having below a 2.0 CGPA may have been able to meet the 3.00 CBK GPA requirement since only the last time the course is taken is used in this calculation, where the calculation for CGPA contains grade for each time a course was taken. For example, a student having taken Calculus twice and received an "F" initially and a "C" the second time would only have the grade of C counted for CBK GPA but would have both the F and the C grades counted in CGPA. This also should be monitored in light of the new TAMU *Grade Exclusion* policy adopted for first-year students that allows the option of

excluding up to three courses during the first year of their studies from their GPA calculation.

- The Engineering Academic Program Office needs to ensure counseling for potential and new entry transfer students occurs, and programmatic information session for community college counselors/advisors related to what coursework is transferable.

Recommendations for Future Research

- Conduct another study indicating the relationship of time to completion of CBK with regard to graduation
- Perform a study to discover what pre-existing or college environmental factors at TAMU are or are not capturing or maintaining women's interest in engineering
- Analyze minority students (Hispanic and African American) time to completion of CBK compared to time to degree completion to see if once they complete CBK they remain in the pipeline and complete an engineering degree
- Execute a study addressing the question if UFN has a relationship to cumulative grade point average or overall degree completion for engineering majors and to examine the *Hopwood* and post-*Hopwood* impacts on minority student scholarships.
- Continue ongoing data collection on current student cohorts (i.e. 2003, 2004) to compare of UFN percentages and relationship to time to completion due to

increased cost of college attendance outpacing the rate of inflation nationally and at this institution

- Conduct a qualitative study with a purposive sample with regard to females, minority and students with UFN.
- Further study to determine other factors relevant to why Computer Engineering majors are completing CBK at a slower rate than other majors.
- Investigate why Chemical engineering majors complete CBK faster than any other major addressed in this study, with special focus on the gender, ethnicity and Unmet Financial need of Chemical engineering students to obtain profile of those who are successful.
- Determine "gate-keeping" courses by gender, ethnicity, and major for CBK and non-CBK courses since all contribute to the CGPA calculation.
- Determine through further analysis why the 196 students had CGPAs below that published as acceptable by the departments in this study for progress to upper division status.
- Further study of the literature and an applicable future study to determine additional independent variables having relationship to time to completion of CBK, since the variables in this study accounted for 19% of the total variance. Based on review of literature for this study, these might include high school coursework and grades (preparation) in mathematics and science, high school rank, hours worked, and qualitative factors such as motivation, time management and study skills, or level of parental education.

Discussion

The strongest relationship to completion of CBK of any independent variable in this study was CGPA, which was found to have statistical significance. Statistically significance was also found for the variables ethnicity, unmet financial need, and for majors in Chemical, Electrical, and Computer Engineering. Transfer credit was the one variable in this study that did not show statistical significance in relation to time to completion of CBK.

The literature indicates that minority and low income students often do not succeed in completion of an engineering degree; this study found that the two factors have statistical significance in the first step toward obtaining a TAMU engineering degree, which is completing of CBK. The strongest relationship of time to completion of CBK is CGPA, indicating the need for adequate preparedness of students. Therefore this study aligns with the national data indicating that the academic preparedness and not the factors of ethnicity contribute to successful student progression.

RQ1 - What is the relationship between gender and time to completion of CBK?

Female students are completing CBK faster than male engineering students. Therefore, findings from this study indicate that gender is significantly related to completion of CBK with female engineering students completing CBK faster than males. This finding aligns with national research findings discussed in Chapter II that showed that women entering engineering degree programs are prepared as well as or better than their male counterparts and able to handle the rigorous foundational engineering pre-requisite curriculum. It also aligns with current institutional research that indicates that women are not departing engineering majors at TAMU due to academic difficulty or inability to complete CBK coursework in a timely manner.

Although the difference in time to completion between males and females is statistically significant, the overall impact of gender on time to completion of CBK is very small ($R^2 = 0.6\%$). This demonstrates a danger in looking only at statistical significance without examining effect size. Though analysis results in statistical significance, the amount this variable contributes to the relationship of variables in this study is minute compared to what remains that is attributed to the other five variables.

Recommendations

Gender, though statistically significant, does not contribute a large amount to the relationship of time to completion of CBK. Therefore, further study may be warranted to discover what pre-existing or college environmental factors at TAMU are or are not capturing or maintaining women's' interest in engineering. Further qualitative study of female engineering students persisting at TAMU may lend insight as to what factors contribute to their completion of an engineering degree. Once isolated, those factors may be further analyzed quantitatively or qualitatively regarding any applicable intervention mechanisms that might increase retention and graduation success, which is measured by or defined as degree completion.

Also, because of the fact that the women enrolling in engineering are completing CBK faster than males, the College may look to enhance programs targeted at recruiting and retaining women as those attracted to the major appear to be outperforming the males. It would be particularly interesting to see if relationship to time to completion of CBK and ultimate graduation also occurred based on majors, as relates to Question # 4.

RQ2 - What is the relationship between ethnicity and time to completion of CBK?

The study found a statistically significant difference at the 0.01 level ($p = .001$) in mean time to completion of CBK between minority and non-minority students. Minority (African American and Hispanic) students are taking slightly longer than non-minorities to complete CBK, with African Americans taking the longest period of time to complete CBK ($\mu = 3.23$ semesters; $\sigma = 1.04$) and was the only group not to have individuals complete CBK in one semester. Ethnicity for African American ($p= 0.011$), Hispanic ($p= 0.036$), and White ($p= 0.020$) students is statistically significant at the 0.05 level in relationship to time to completion of CBK.

All four ethnic groups had students who took a maximum of six semesters to complete CBK. In discussion with the Engineering Academic Program Office, it was found that there is no policy that indicated students were allowed a maximum of six semesters but that this may tie to the rule that engineering students must be in upper level status by the time they complete 60 hours. One semester is the shortest period of time in which a student could complete CBK. White students were the majority of students completing CBK in 1 semester. Due to their large numbers it was not surprising to find white males are the largest number of students completing CBK in four, five or six semesters. There were more Asian, African American, and Hispanic males than females who took four to six semesters to complete CBK.

Related to gender and ethnicity statistical significance was found between African American and White students ($p = .008$) and between White male and female students ($p = .008$).

Recommendations

Further study may be warranted for Hispanic and particularly African American students to find what factors may be contributing to them taking the longest time to complete CBK and progress to upper division status, particularly related to the literature that indicates many students of these ethnicities are first-generation and low income and may rely more on working to support themselves while in college. One factor the literature indicates that impacts underrepresented minority students is high school mathematics course selection and preparation for college level calculus for engineering majors.

Also, segregating data for those students who took the maximum of six semesters to complete CBK and drawing on further quantitative analysis may indicate the reason behind the fact that all groups have a maximum of six semesters for completing CBK.

RQ3 - What is the relationship between a student's unmet financial need (UFN) and time to completion of CBK?

The study found statistical significance at the 0.01 level ($p = 0.001$) indicating students without UFN are completing CBK faster than those with UFN. The UFN variable contributes less than 1% (R^2 of 0.01 and adjusted R^2 of 0.009) to the total 19% effect size (R^2) of all the variables in this study related to time to completion of CBK.

More than a quarter (26%) of student with UFN took longer than three semesters to complete CBK, while 18% of students without UFN took longer than three semesters to complete CBK. UFN and gender found statistical significance at the 0.01 level ($p = 0.001$) for time to completion of CBK for males but not for females.

Underrepresented minority students (Hispanic, African American) have a larger number of students with UFN than not having UFN. Students taking the longest number of semesters to complete CBK are those with UFN who are African American ($\mu = 3.35$ semesters) and Hispanic ($\mu = 3.22$) students. However, no statistical significance for ethnicity and UFN were found for White, African American, Asian or Hispanic students.

UFN had a statistically significant relationship to time to completion of CBK ($p = .001$), indicating that this factor impacts the length of time a student with need takes to progress to upper level status. It would be assumed that this also will impact time to ultimate progression toward degree or graduation. However, the effect size was very small (adjusted R^2 of 0.009) indicating that the UFN variable contributes little to the overall time to completion of CBK.

Recommendations

Unmet financial need (UFN) has a relationship to completion of CBK with it taking longer for those with unmet need to complete CBK than those without unmet need. Further study is recommended to see if the percentage of students with unmet need has risen as recent publications indicate substantial increases in the cost of higher education and changes to the federal formulas for financial aid calculations that could negatively impact financial aid allocations. Research also indicates students with UFN may often take on employment to fill the gap and fund their college education. Research indicates that working more than 12-15 hours a week begins to put students at retention risk of progression and higher grade point averages, particularly with those working more than 20 hours per week negatively impacting their retention and academic performance (Choy, 2002; Choy et al., 2005). Therefore further analysis regarding the impact of unmet financial need on CGPA and successful degree completion may be merited and would complement this study of relationships to completion of CBK.

RQ4 - What is the relationship between student major and time to completion of CBK?

Chemical engineers finished CBK in less time (μ= 2.56;σ = 0.99) with Computer Engineers taking the longest time to complete CBK (μ= 2.96; σ = 1.00). Findings indicated statistical significance at the 0.01 level for computer engineering student. Statistical significance was not found in the relationship of major by gender to CBK completion for any of the five majors in this study.

Within Electrical Engineering majors, statistical significance was found at the 0.01 level for ethnicity by major on time to completion of CBK, at the 0.05 level for Asian students (0.025) and White (p= 0.012) students, and at the 0.01 level for and Hispanic (p = 0.007) students.

Effect size calculations (R^2 = 0.018) indicate that a student's major is not contributing a large part of to the relationship of the variables in this study. Several of the majors do not show a relationship of any significance to time to completion of CBK.

It is critical to note that the five majors in the study each require a different CGPA to progress to upper division status as well as a 3.00 grade point average in CBK. The overall CGPA required for progression to upper division status for the five majors in this study for 1998-1999 were: 3.125- Computer Engineering; 3.00-Chemical Engineering; 2.75-Electrical and Mechanical Engineering; 2.50-Civil Engineering. Therefore, the major with the highest CGPA requirement were taking the longest to complete CBK, indicating that a higher CGPA requirement may lengthen the time to completion of CBK. However, Chemical engineering was also statistically significant and had a higher CGPA.

Recommendations

Though major contributes very little to the relationship of all the variables in this study on time to completion of CBK (adjusted R^2 of 1.5%), operationally it is at the university departmental levels where policy or procedural changes occur. Therefore, further study is recommended to delve deeper into the implication that time to completion of CBK may be increased by a department setting a higher CGPA requirement since Computer Engineering majors are taking a statistically significant longer time to complete CBK (p 0.021) and had the highest CGPA requirement of the five majors studied. Also, results of RQ5 indicate that CGPA has the strongest relationship and effect size of all variables in this study in time to completion of CBK.

RQ5 - What is the relationship between cumulative grade point average and time to completion of CBK?

The use of CGPA by the TAMU College of Engineering as a means of allowing progression to upper level status appears to be impacting the time to completion of CBK. Statistical significance was found for Computer Science which is the department with the highest CGPA requirement of 3.125 in 1998-1999. The statistical significance, strength of the relationship, and contribution to overall effect size by this variable are the strongest of all independent variables in the study.

CGPA is the strongest determining factor in this study for completion of CBK and progression to upper level status by the five majors studied. Results of the relationship of CGPA to time to completion are statistically significant at the 0.01 level, with a strong correlation ($r = -0.408$, $p = 1.2*10^{-22}$). Results indicates almost no probability ($p = 1.2*10^{-22}$) that the statistical result was obtained by chance and the correlation for the relationship of CGPA to time to completion is very strong. The negative r indicates that the higher the CGPA the less number of semesters a student takes to completion of CBK.

The variable CGPA is responsible for over 16% (R^2, 0.167; adjusted R^2 of 0.166) of the total 19% effect size (R^2) of all the variables in this study related to time to completion of CBK.

Minority students had lower mean CGPA than non-minority students did. Students with no UFN have a mean CGPA slightly higher than those with UFN. Statistical significance was found at the 0.01 level for every subgroup by gender, ethnicity, UFN, and major EXCEPT for African American (p= 0.108). Further study is needed to reveal any circumstances for African American students that do not exist for other groups, particularly in light of the fact that the other minority group of this study, Hispanic students, did show statistical significance.

There were 196 students that progressed to upper division status with less than a 2.0 CGPA, which is inconsistent with College policy requiring at minimum within the five majors a 2.0 to advance to upper division status upon completion of CBK.

Recommendations

Further study is needed to determine why the 196 students had grade points below that published as acceptable by the departments in this study for progress to upper division status and to verify the conclusion that retaking a course may benefit CBK grade point average but does not impact CGPA since all times a course is taken is calculated in CGPA.

Review of the data by major and CGPA might also be made to allow for individual presentation to the various departments for their review or adjustment to existing policy regarding progression to upper division status by completion of CBK. Very few, if any studies exist nationally on the completion of CBK, yet this progression path with established and ridged pre-requisite courses is very common among engineering schools. University students, particularly upper level students, are tied directly to their department so the information would be useful for administration and faculty, particularly advising faculty and staff, at the departmental levels.

Since certain ethnicities and gender were shown to be statistically significant in their relationship to CBK, a separate analysis of interactions of those factors with CGPA might be warranted. Analysis should also be made of CGPA at time of graduation by students to see if there are factors relating to completion that exist after completion of CBK and progression to upper division status.

RQ6 - What is the relationship to credit hours transferred at time of enrollment in engineering at TAMU and time to completion of CBK?

Data indicates that transfer credit does not have a statistically significant relationship to completion of CBK. Hispanic students transferring in hours is the only factor with a quasi-relevant relationship to CBK completion ($r = 0.211$, $p = 0.054$).

Recommendations

Further study should be made to determine which of the total hours transferred and accepted by TAMU for a student were CBK hours. Data obtained for this study did not break out what course credits transfer hours were, so CBK transferred in could not be identified. Further analysis of students transferring in credit hours is recommended to identify if community college transfer students are taking longer to complete CBK than entering first year student, which appears to be the case, or what courses may be gate-keeping courses as they often impact transfer students to a greater degree than first time enrolling students as show by Hanson (1998). If so the College may want to address this issue since community colleges are often populated by first-generation and minority students. Review of the literature indicates both groups are ready pools to increase the engineering enrollment and are at greater risk for degree completion, particularly Hispanics attending community colleges and have the added complication of the transfer process in order to obtain a baccalaureate degree.

The College of Engineering's policy is that students enter as lower division and are to complete CBK and move to upper division status within 60 hours. Transfer students upon initial enrollment enter as lower division status and must complete CBK to advance to upper division status. Therefore the College may need to consider a mechanism for informing community college faculty and counselors working with potential transfer students to ensure appropriate courses are taken and when the most optimum time for transferring is for students.

Interaction effects for gender, underrepresented minority status, and unmet financial need

Only one statistically significant result at the 0.01 level for the main effect of ethnicity was found, with a very small chance of error ($p = 0.007$). No statistical significance was found for the interaction effects of gender, ethnicity and UFN.

However, it may be worthwhile to look at the statistical percentages by gender of African American students with unmet financial need compared to other minorities and by gender related to degree completion and not merely time to completion of CBK. It is unknown through this study whether the continued reliance on financial aid in any way impacts completion of a degree.

Summary

There were 1165 first-time entering students in the Dwight Look College of Engineering at Texas A&M University for the Fall 1998 and 1999 in the five majors of Chemical, Civil, Computer, Electrical and Mechanical engineering. The ethnic mix is similar to the national enrollment in engineering with White males being the majority and minority students (African American and Hispanic) being approximately 10% of the student population in this study. Chemical Engineering had the greatest number of female student and Computer Engineering had the greatest number of ethnic minorities.

Six variables were examined for relationship to time to completion of the Core Body of Knowledge (CBK) requirement, which is a precursor to progression to upper division status in the College. The variables of CGPA, gender, ethnicity, unmet financial need, and for Chemical, Electrical, and Computer Engineering majors were found to have a statistically significant relationship to CBK. The variable transfer credit hours did not show statistical significance in relation to time to completion of CBK.

Results of the analysis show that cumulative grade point average (CGPA) had the strongest relationship to completion of CBK of any independent variable in this study. The interaction effects associated with gender, minority status, and unmet financial need were not found to be statistically significant. An additional finding that has implications for practice is that females ate taking less average time to complete CBK than males at a statistically significant level.

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