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Factors That Contribute to Persistence and Retention of Underrepresented Minority Undergraduate Students in Science, Technology, Engineering, and Mathematics (STEM)

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The University of Southern Mississippi

FACTORS THAT CONTRIBUTE TO PERSISTENCE AND RETENTION OF UNDERREPRESENTED MINORITY UNDERGRADUATE STUDENTS IN SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM)

by

Sidney Kirk Mitchell

Abstract of a Dissertation
Submitted to the Graduate School
of The University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy

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ABSTRACT

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The objective of this research was to identify specific factors that contribute to underrepresented minority (African American, Hispanic, Native American) undergraduate students' success in STEM disciplines at a regional university during the 2007-2010 timeframe. As more underrepresented minority (URM) students complete STEM degrees, many will possess the skills to become part of the domestic human capital needed to meet U. S. workforce demands and enhance the nation's STEM innovation. According to Burke and Mattis (2007), the lack of URM students in STEM education and in the workforce is one of the major contributors to STEM shortages in the United States.

In this study, the investigator employed a sequential mixed method design to comprehensively examine which specific factors contributed to URM student success in STEM. Mixed methods design was necessary in order to capture the complexities of factors contributing to URM persistence and retention in STEM disciplines. Data collection and analysis was conducted to address four research objectives in two distinct sequential phases.

In Phase I, quantitative analysis of archival data (taken from the regional university's ISIS and SAM databases) was used to explore the impact of specific factors on URM student persistence and retention. Logistic regression was used as the statistical procedure to examine objectives one and two. In Phase II, qualitative data were collected and analyzed using a nominal group technique. The researcher met with eighteen URM students (11 African American, four Hispanics, and three Native American) and posed two questions based on the quantitative findings as to why they persisted and were retained in STEM disciplines.

This study was designed to help students and this institution better understand how URM students can navigate and overcome barriers to obtaining STEM degrees. According to George, Neale, Van Horne, and Malcolm (2001), tapping the reservoir of URM could help in meeting the STEM workforce demand as these minorities continue to show great increases in college enrollment. The findings for objectives one and two revealed four factors that were statistically significant contributors of URM student success in STEM disciplines. They included college GPA, academically rigorous curriculum, percent of hours completed, and percent of hours passed. The findings of objectives three and four revealed the top five rankings of URM persistence and retention factors in STEM success. The researcher employed a nominal group technique to collect and analyze this qualitative data.

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Finally, I praise God for the sun and the rain and for the blessing of His *rainbow*, which reminded me that no matter how dark the night, or heavy the rain, this too shall pass. Thus, I conclude by quoting Isaiah, 66:9, “Shall I bring to the point of birth, and not give delivery?” says the Lord. Lord, you have delivered and birthed this vision, and the now Dr. Sidney Kirk Mitchell, Sr., humbly says, “Thank you, Jesus!” May the essence of this accomplishment be a light to others that they may know; with God’s help and hard work, it can be done. Amen!

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LIST OF ABBREVIATIONS

AAAS	American Association for the Advancement of Science
ALANA	African, Latino/a, Asian, and Native American
BEST	Building Engineering and Science Talent
BLS	Bureau of Labor and Statistics
CPST	Commission on Professionals in Science and Technology
DOD	Department of Defense
GPA	Grade Point Average
HBCU	Historically Black Colleges and Universities
ISIS	Integrated Student Information Systems
LSAMP	Louis Stokes Alliance for Minority Participation
LS-LAMP	Louis Stokes Louisiana Alliance for Minority Participation
MIT	Massachusetts Institute of Technology
NACME	National Action Council for Minorities in Engineering
NASA	National Aeronautics and Space Administration
NGT	Nominal Group Technique
NCES	National Center for Education Statistics
NSF	National Science Foundation
OIS	Office of Information Systems
PSE	Post-Secondary Education
R&D	Research and Development
SAM	Student Aid Management
SETDA	State Educational Technology Directors Association
SPSS	Statistical Package for the Social Sciences
STEM	Science, Technology, Engineering and Math
TOPS	Tuition Opportunity Program for Students
URM	Under-Represented Minorities
USDA	United States Department of Agriculture
WBI	World Bank Institute

CHAPTER I

INTRODUCTION TO THE STUDY

Background

After World War II, the United States led the world in educational attainment by massively increasing educational enrollments at the elementary, secondary, and postsecondary levels (Toulmin & Groome, 2007). Challenged by the Soviets successful launch of Sputnik, the United States concentrated on a collective, coordinated, and sustained effort to prepare science and engineering talent (National Science Board, 2010). During this period of innovation, new products and processes emerged which significantly expanded America's economic base, created jobs, and gave the U.S. an advantage against foreign competitors (Lips & McNeill, 2009). Research focusing on economic growth shows that most of the technological innovation and its patents were linked to the disciplines of science, technology, engineering, and math (STEM). Examples of technological innovation include an automobile industry that successfully converted back to producing cars in massive amounts and new industries such as aviation, air conditioning, and television.

In the last 50 years, more than half of America's sustained economic growth has been fueled by its engineers, scientists, and advanced-degree technologists because of their education, scientific knowledge, and technological innovation (Shultz, Metz, Lowes, McGrath, & McKay, 2008). Innovation and growth in STEM fields remain critical to America's economic power, national security, and healthcare. Economic and educational literature show that the United States depends heavily on advancements in STEM fields to maintain its position as a global influence (Machi, McNeill, Lips, Marshall &

Carafano, 2009). However, many challenges lie ahead as global economic changes continue and competition with foreign emerging markets intensifies**.**

Two key examples of global influences include China's rapid growth in electrical engineering and computing along with India's enormous strides in accounting and financial service. These factors, when coupled with the severe shortages of American workers to meet the vast demands for a STEM workforce, signal potentially perilous economic consequences for the United States (Machi et al., 2009). As global economic competition increases, countries across the world are strategically planning to hold on to their human capital and intellectual properties, while seeking greater market shares. One mechanism used by emerging economies to attain global economic influence is to educate and train a workforce that fills the greatest need--the need for innovation and development in STEM fields. This is very important as STEM workforce demands continue to vastly increase.

The STEM Status Quo in the United States

The U.S. Department of Labor's 2014 workforce predictions reveal that 15 of the 20 fastest growing occupations will require significant science or mathematics training to successfully compete for a job (State Educational Technology Directors Association [SETDA], 2008). Furthermore, of the ten fastest growing occupations in the United States, eight are science or technology related (Van Kooten, 2008). The United States Bureau of Labor Statistics (2007) projects the number of engineering positions will increase by 160,000 between 2006 and 2016. This number reflects approximately an 11% increase and is really an underestimation since it does not take into account the replacement of many retiring engineers, who are of the baby boomers generation.

Additionally, as the U.S. economy becomes more science and technology-based; fewer American students are studying STEM disciplines (Atkinson, Hugo, Lundgren, Shapiro, & Thomas, 2007). Consequently, many U.S. businesses are importing talent and exporting jobs as U.S. colleges and universities fail to meet the demand for scientists and engineers. While outsourcing and offshoring may be short-term solutions; importing talent, exporting jobs, and increasing H-1B visa allotments do not constitute sound national policy (Slaughter & McPhail, 2007). When it comes to human capital, Burke and Mattis (2007) assert, "Education is the most important investment a country makes generating future prospects" (p. 4) in STEM disciplines and the workforce. While many factors must be considered to meet STEM shortages, tapping the reservoir of under-represented minorities (URM) could help in meeting this emerging national need as these minorities continue to show great increases in college enrollment (George, Neale, Van Horne, & Malcom, 2001). Understanding which factors contribute to the persistence and retention of future under-represented minorities in STEM fields could prove a wise American investment with a great return on the nation's workforce, technological advancements, and educational development.

Conceptual Underpinnings for the Study

According to the National Center for Education Statistics ([NCES], 2003), persistence is identified as a student measure, and retention is identified as an institutional measure. Persistence is the term used by administrators and faculty in higher education to depict a student's ability to complete degree requirements (Yorke & Longden, 2004). As it relates to retention, research shows that a key component for persistence is opportunities for student involvement or engagement at the institutional level (Tinto, 2005). A review of the literature yields several key models that focus on persistence and retention theories. Three models are examined which relate to this study. Tinto, Astin, and Padilla's theories focus on factors that contribute to students' success in college. First, Tinto describes the Interactionalist Student Departure Model, which focuses on the need to better understand the relationship between student involvement in learning and the impact that involvement has on student persistence (Milem & Berger, 1997). Next, Astin's Input-Environment-Outcome Model of Involvement relates to this study because of its focus on the control for input differences, resulting in a more accurate estimate of how environmental variables affect student outcomes (Thurmond, Wambach, Connors & Frey, 2002). Finally, Padilla's (2001) local expertise model of minority student success, which seeks to identify the campus specific heuristic knowledge and actions that successful minority students employ to overcome barriers to academic success, adds to the field. Common factors shared by all three models are academic and social integration as well as student involvement.

Studying the academic persistence and retention of students from a variety of backgrounds in STEM disciplines has several benefits. Perhaps most beneficial, however, is understanding how URM students succeed academically, which can be useful in assisting other at-risk students (Morales, 2000). According to Clewell and Campbell (2002), some research relates the challenges of URM to the STEM education pipeline. Burke and Mattis (2007) advocate, "While these challenges are not new, there is a heightened sense of the nature of the problem [of the shortages of URM in STEM disciplines] coupled with a more focused commitment to do something about it" (p. 24). The United States faces a demand for STEM talent that is both urgent and pressing.

Statement of the Problem

Studies have been done that focus on the failure of URM students in STEM disciplines, but not enough information exists on student success. In addition, studies addressing the lack of student persistence or retention in STEM disciplines and the decisions of URM students to switch to other fields of study are plentiful. Stakeholders on many levels grapple with the issue that fewer American students are entering STEM disciplines. White and Asian Americans represented 82.3% and 10.4% of the STEM workforce, respectively, while African Americans, Hispanics, and Native Americans were 3.4%, 3.1%, and 0.3% of this population (Bonous-Hammarth, 2000). According to Davis (1996), the more URM students that enter STEM and are successful, the larger the pool of scientists and engineers will become, resulting in a talent pool of better quality. Burke and Mattis (2007) assert, “In addition, this diversity is likely to improve the level of creativity, innovation, and quality of STEM products and services” (p. 7). Science, technology, engineering, and mathematics are vital to American competitiveness; yet, relatively few students obtain a STEM bachelor’s degree (Business-Higher Education Forum, 2010) and URM students in STEM disciplines earn even fewer degrees. When it comes to STEM, minority students represent an untapped resource (Burke & Mattis, 2007). If more URM students enroll and persist through the STEM pipeline, the results could be a greater talent pool, more creativity and innovation, and more skilled workers to help meet the vast STEM demand in the United States.

Purpose of the Study

The purpose of the study is to identify factors that contribute to persistence and retention of URM students enrolled in STEM disciplines at a regional university during the 2007-2010 time periods. Toliver (2005) asserts that all stakeholders and policymakers must understand that retention is not just a minority problem; it is an institutional challenge. Slaughter and McPhail (2007) predict minority participation in post-secondary education will increase from 32% to 38% by 2025. According to the National Science Foundation, (2004), the URM student population between the ages of 18 and 24 will be an estimated 50% by 2050. If URM students' persistence and retention continue to decrease in STEM disciplines, U.S. institutions and the nation as a whole will continue to lag behind in human capital and productivity. Therefore, it becomes necessary that institutions be prepared to meet the challenge of preparing minority students to successfully navigate STEM disciplines. This researcher's specific aim is to investigate factors that contribute to the persistence and retention of URM students who have enrolled in STEM at a regional university during the 2007-2010 academic years.

Significance of the Study

Understanding what factors contribute to persistence and retention of URM students in STEM disciplines will help students and institutions better navigate and overcome barriers to obtaining STEM degrees. As more URM students complete STEM degrees, many will possess the skills to become part of the domestic human capital needed to meet U. S. workforce demands and enhance the nation's STEM innovation. More research is needed to identify factors that contribute to the persistence and retention of successful URM students in STEM disciplines. Their skills are vital to the American economy, national security, as well as research and development (Smythe & McArdle, 2004). Educating and training URM in STEM disciplines "provides benefits to all students, which will in turn help ensure a productive, innovative, workplace in all fields for decades to come" (Morris, 2006, p. 2).

Research Objectives

The researcher will examine the following research objectives:

O_1: Determine the extent to which each of the following factors impact URM student persistence in STEM disciplines at a regional university: (a) ACT composite score, (b) participation in an academically rigorous curriculum, (c) financial aid, (d) college Grade Point Average (GPA), (e) social integration, and (f) percent of hours completed.

O_2: Determine the extent to which each of the following factors impact URM student retention in STEM disciplines at a regional university: (a) ACT composite score, (b) participation in an academically rigorous curriculum, (c) financial aid, (d) cumulative GPA, (e) social integration, (f) percent of hours completed, and (g) percent of hours passed.

O_3: Identify factors that influence the perceived persistence of URM students in STEM disciplines at a regional university.

O_4: Determine the extent to which student support services impact the perceived retention of URM students in STEM disciplines at a regional university.

Limitations, Delimitations, and Assumptions

In seeking answers to these research objectives, the following limitation of this study is noted: The regional university has selective admissions requirements. This study was delimited to under-represented minority students majoring in STEM at a single regional university; and it was delimited exclusively to the number of students enrolled in this regional university during the Fall 2007-Spring 2010 time frame. Hispanic and Native American participation will be minimal based on their availability and low numbers of enrollment within the target population at the regional university. Additionally, it is assumed that all participants taking part in the case studies gave accurate responses, and that URM students felt comfortable enough to participate in the nominal group (qualitative) phase of this study.

Definition of Key Terms

1. Academic Integration: The development of a strong affiliation with the college academic environment both in the classroom and outside of class. Includes interactions with faculty, academic staff, and peers but of an academic nature such as peer tutoring or study groups (Kraemer, 1997).
2. Building Engineering and Science Talent (BEST): A public and private partnership dedicated to building a stronger, more diverse U.S. workforce in science, engineering and technology by increasing the participation of underrepresented groups (Jackson, 2002).
3. Categorical aggregation: An aspect of data analysis in case study research where the researcher seeks a collection of instances from the data, hoping that issue-relevant meanings will emerge (Creswell, 1998).
4. Constructivist perspective: A mental view or outlook that learners bring their personal experiences into the classroom, and these experiences have a tremendous impact on students' views of how the world works. Students come to learning situations with a variety of knowledge, feelings, and skills, and this is where learning should begin. This knowledge exists within the

student and is developed as individuals interact with their peers, teachers, and the environment. Learners construct understanding or meaning by making sense of their experiences and fitting their own ideas into reality (Shulte, 1996).

5. Cultural Capital: A set of values, beliefs, norms, attitudes, experiences and so forth that equip people for their life in society. Students are not simply socialized into the “values of society as a whole.” Rather, they are socialized into the culture that corresponds to their class and, in Bourdieu’s terms, this set of cultural experiences, values beliefs and so forth represent a form of “Cultural Capital” (Bowles & Jensen, 2001, p. 1).

6. Dropout: Students who leave the university before completing their degree program.

7. H-1B Visa: A non-immigrant visa, which allows a US company to employ a foreign individual for up to six years. The H1B visa is designed to be used for staff in "specialty occupations," that is those occupations that require a high degree of specialized knowledge. Generally at least the equivalent of a job-relevant 4-year US Bachelor's degree is required (United States Citizenship and Immigration Services, 2009).

8. Integrated Student Information Systems (ISIS): A database that incorporates most of the administrative information in the regional university used in this study. Faculty advisors may obtain accounts to access student records. Departmental administrative staff may use it to access departmental records (University of Louisiana at Lafayette, 2010).

9. Louis Stokes Alliance for Minority Participation (LSAMP): A program aimed at increasing the quality and quantity of students successfully completing STEM baccalaureate degree programs, and increasing the number of students interested in, academically qualified for and matriculated into programs of graduate study. LSAMP supports sustained and comprehensive approaches that facilitate achievement of the long-term goal of increasing the number of students who earn doctorates in STEM fields, particularly those from populations underrepresented in STEM fields. (National Science Foundation, 2003).
10. Louis Stokes Louisiana Alliance for Minority Participation (LS-LAMP): A comprehensive, statewide, coordinated program aimed at substantially increasing the number and quality of minority students enrolling in and completing baccalaureate degrees in science, technology, engineering, and mathematics (STEM) and subsequently going on to pursue graduate studies in STEM disciplines (LSAMP, 2010).
11. National Center for Education Statistics (NCES): An agency, which collects, analyzes, and makes available data related to education in the United States and other nations.
12. Nominal Group Technique: A structured variation of a small-group discussion to reach consensus. Nominal (meaning in name only) group technique (NGT) gathers information by asking individuals to respond to questions posed by a moderator, and then asking participants to prioritize the ideas or suggestions of all group members. The process prevents the

domination of the discussion by a single person, encourages all group members to participate, and results in a set of prioritized solutions or recommendations that represent the group's preferences (Center for Disease Control and Prevention, 2006).

13. Offshoring: The transfer of service operations to foreign countries in order to take advantage of a supply of skilled but relatively cheap labor. Services may be outsourced to a foreign company, or a wholly owned foreign subsidiary company may be established. The main benefit of offshoring is the reduction of costs, but concerns about redundancies and job losses in the home countries have been raised (Hiner, 2008).

14. Persistence: Persistence is identified as a student measure (National Center for Education Statistics, 2003). For the purpose of this study persistence is defined as an URM student consecutively enrolled during the Fall 2007 – Spring 2010 semesters in a STEM discipline at the same regional university.

15. Retention: Retention is identified as an institutional measure (National Center for Education Statistics, 2003). For the purpose of this study retention is defined as an URM student enrollment for at least one additional semester between the Fall 2007 – Spring 2010 time frame in STEM at the same regional university.

16. Science, Technology, Engineering, and Math (STEM): STEM fields which can include a wide range of disciplines. For example, the National Science Foundation (NSF) defines STEM fields broadly, including not only the common categories of mathematics, natural sciences, engineering, and

computer/information sciences, but also disciplines such as social/behavioral sciences, psychology, economics, sociology, and political science (Green, 2007).

17. Social Integration: The development of a strong affiliation with the college social environment both in the classroom and outside of class. Examples include interactions with faculty, academic staff, and peers of a social nature such as peer group interactions, informal contact with faculty, and involvement in organizations (Kraemer, 1997).
18. Student Aid Management (SAM): A database at a regional university where student financial information is stored.
19. Thematic Analysis: Historically, a conventional practice in qualitative research that involves searching through data to identify any recurrent patterns. A theme is a cluster of linked categories conveying similar meanings and usually emerges through the inductive analytic process which characterizes the qualitative paradigm (Subvista, 2010).
20. Under-Represented Minority Students (URM): The federal definition of a minority employee includes all U.S. citizens, naturalized or permanent residents that have African, Hispanic, or Native American heritage. At MIT and most other STEM institutions, the under-represented minority (URM) refers to those minority groups that are not represented in the STEM fields in numbers proportional to their composition in the U.S. population (Reif, 2010).

Summary

This research seeks to explore factors that contribute to the persistence and retention of undergraduate minority students in STEM disciplines at a regional university during the Fall 2007-Spring 2010 time frame. A comprehensive literature review is presented in the next chapter, which includes an overview of U.S. STEM competitiveness in the global economy.

It is essential that the United States acts now to ensure all students can continue to prosper in the 21st century technology-based economy (Beering, 2009). The lack of URM students in STEM disciplines and the workforce further deepens U.S. STEM shortages and hampers productivity. Understanding what factors influence URM college student persistence and retention in STEM fields is crucial for institutions of higher education and increased URM successes. If under-represented minorities continue to circumvent or to switch away from STEM fields, the results will generate negative educational and economic implications, and higher education in the United States will not meet the market demands of a highly technical society.

A Conceptual Framework to Increase URM Persistence and Retention in STEM at the University of Louisiana at Lafayette

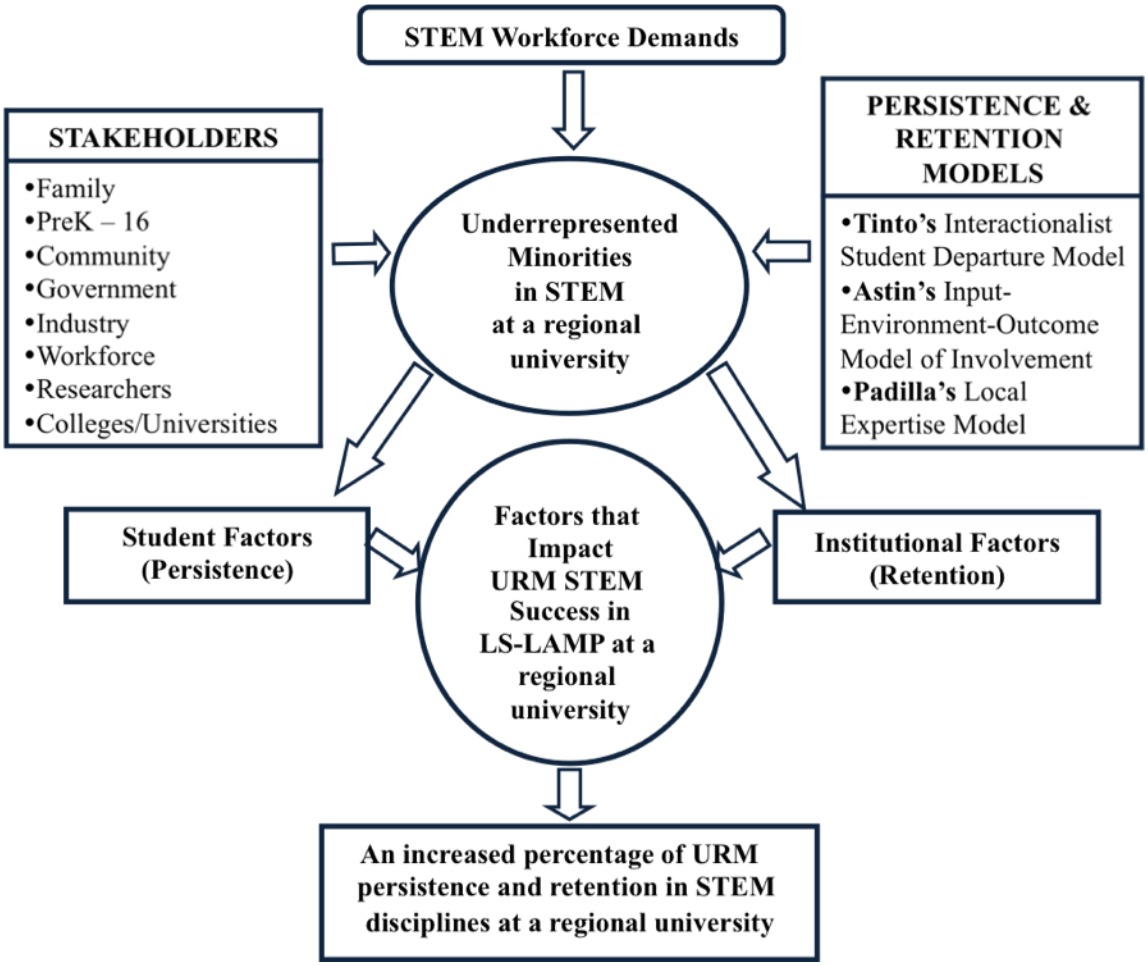

Figure 1. Conceptual Framework.

CHAPTER II

REVIEW OF LITERATURE

This chapter provides a synthesis and critique of the theoretical and empirical literature on the factors that contribute to persistence and retention of under-represented minority (URM) students enrolled in undergraduate science, technology, engineering, and math (STEM) disciplines. Under-represented minorities are identified as African Americans, Hispanics, and Native Americans for the purpose of this study. The National Action Council for Minorities in Engineering (NACME) reveals that the already low number of minority students pursuing STEM degrees and careers has plateaued or even declined in recent years (Microsoft Corporation, 2008). According to Clewell (2002), the failure to invest in all STEM talent and to reform STEM education is a threat to America's economic well-being and future security. The U.S. must address the crisis of having a disproportionately low representation of minorities in STEM disciplines in order to increase its STEM talent pool and to remain globally competitive.

This review of literature provides a summary of relevant literature in relation to URM students' persistence and retention in STEM fields. It has been organized into four sections. The chapter begins with a synopsis of the U.S. competitiveness in STEM as it relates to the global economic competitiveness. Then, theoretical models on persistence and retention, which include Tinto's Interactionist Model of College Student Departure (1975, 1993), Astin's Input-Environment-Outcome Model of Involvement (1993), and Padilla's Local Expertise Model of Minority Student Success (1999), are synthesized and reviewed. Next, the Louis Stokes Alliance for Minority Participation (LSAMP) and the Building Engineering and Science Talent (BEST), two research-based innovative practice programs shown to foster persistence and retention of URM in STEM disciplines, are examined. This chapter concludes with a critical examination of major factors that contribute to the persistence (student factors) and retention (institutional factors) of URM students enrolled in undergraduate STEM disciplines.

United States STEM Competitiveness in a Global Economy

Education is not only training for productivity, but also for enabling and empowering citizens to take part in local, regional, and national government in the form of participatory development (Gilmore, 1999). According to Burke and Mattis (2007), education is the most important investment a country makes in generating future prospects of its economic prosperity. In a changing world that demands higher skill levels and competencies from its workforce, increasing the local capacity and use of all human capital through education and policy is critical for success (DeVol & Wong, 1999).

For over 50 years, the Unites States has enjoyed the preeminence of being the world leader in STEM disciplines. Advances in STEM innovation have been a major contributor to the nation's economic development since WWII (Berezdivin, 2009). America's influence in the global economy has been the product of an educated and skilled STEM workforce, which has led to higher living standards and an improved quality of life for many U.S. citizens (Burke & Mattis, 2007). However, as developing countries such as China, India, and Russia strategically position themselves to gain the power and privileges of having their own STEM educated workforce (United States Chamber of Commerce, 2005), the United States finds itself in fierce competition.

Ensuring America's continued competitiveness in an increasingly challenging global economy requires significant improvements in STEM education (Honda, 2008).

Furthermore, Hira (2009) contends "policy has done little to reduce risks and uncertainty for STEM workers" (p. 7). The nation faces challenges with competition from developing countries such as China, which produces 550,000 engineers per year and India, which produces 370,000 engineers per year. On the other hand, the United States produces a combined total of approximately 50,000 engineers yearly in its 319 engineering colleges (Allen, 1999) of which a fair percentage is foreign born talent. Moreover, China surpassed the United States in information technology exports in 2004 and is predicted to match the U.S. economy in size by 2041 (National Science Foundation, 2005). India is expected to become the third largest economy in the world (Yallapragada, Toma & Roe, 2007) because of its technological revolution and innovative educational practices.

In the area of higher education, America now lags far behind many countries in the percentage of its college graduates majoring in science and technology (Kuenzi, 2008). For example, the United States ranks 20th among all nations in the proportion of 24 year-old students who earn degrees in engineering or natural science (Kuenzi, 2008). Moreover, the Information Technology and Innovation Foundation (Atkinson et al., 2007), a research and educational institute located in Washington, DC, emphasized that the United States ranks 29th of 109 countries in the percentage of 24 year old students who earn a math or science degree. Further splintering a U.S. focus on producing STEM graduates and a technological workforce, are mounting domestic concerns about the growing need for carbon-free energy, environmental protection, and the nation's decaying infrastructure (Abbey & Lane, 2009).

According to the United States Department of Labor (2007), American preeminence in STEM fields will not remain secure or advance without concerted efforts and investments from its public, private, and non-profit entities to promote innovation and to prepare an adequate supply of qualified workers in STEM fields. In October 2007, the National Science Board asserted in its STEM Action Plan that the U. S. must enhance its, “ability to produce a numerate and scientifically and technologically literate society and to increase and improve the STEM education workforce” (p. vii). Higher education must develop its emerging URM talent pool, which will increase diversification much more than it has in the past. Chubin, May, and Babco, (2005) assert that increased URM participation and diversity in STEM will, in part, help meet the nation’s need for world-class prospects in America’s workforce. It is imperative that more under-represented minorities, in particular, be educated and skilled to help meet the increasing U.S. STEM workforce demands, to promote economic competitiveness, and to contribute to America’s innovation and productivity (Friedman, 2005; National Science Foundation, 2005; Pearson, 2005).

As part of human capital development, education unmistakably needs to be provided to all future workers and especially those who are underrepresented in the STEM workforce (Gilmore, 1999). Leggon (2006) contends that the United States cannot afford to squander its human resources; it is imperative that the nation develops and nurtures all of its citizens not merely as a response to a social problem or moral imperative, but as an answer to an economic problem and a national imperative. Regions that plan to participate in this new high tech economy will have to provide quality human capital in order to remain globally competitive. Gilmore (1999) further asserts that firms will need diverse and qualified personnel to succeed in the new economy. Diversity among race, gender, ethnicity, as well as persons with disabilities must be incorporated into this STEM sector (George et al., 2001).

While there are many factors to be considered in meeting STEM shortages, tapping into the reservoir of URM could help in meeting this national need as minorities continue to show great increases in college enrollment (George et al., 2001). According to Slaughter and McPhail (2007), URM in undergraduate studies in particular are expected to increase to 32% in 2010 and to 38% in 2025 (National Action Council for Minorities in Engineering, 2008). Bressoud (2009) contends, however, that although the percentage of URM students earning bachelor's degrees has increased since 1990, the proportion of such students majoring in mathematics and science has stagnated for decades. When it comes to STEM disciplines in particular, White (2005) argues that interest has been declining on college campuses since 1967.

The United States must continue to strategically invest in its STEM workforce and URM students could prove to be a more than satisfactory return over the long-term (Jackson, 2007). In Thomas Friedman's 2005 bestseller, *The World is Flat*, he refers to America's lack of preparation for the global, technology-intensive and robust economy as the "quiet crisis" (Center on Education and Work, 2008, p. 1). In addition, the phrase "quiet crisis" was employed by Jackson (2007), president of the Rensselaer Polytechnic Institute, in the following statement:

> I have described this looming science, engineering, and technology workforce gap as a "quiet crisis" because it is creeping up on us. The danger is in waiting to address the crisis until it is upon us, because then – due to the cumulative, decades-long nature of the education of a scientist or engineer – it will be too late.

> We must wake up to the crisis because the United States' capacity for innovation is inextricably interlinked with our economic and national security. Failure to act soon will undermine our national capacity for innovation, thereby threatening our economic well-being, safety, and global leadership. (p. 3)

Land-Grant Colleges and Universities

Jackson (2007) advocates that innovation requires consistent investment in research and development (R&D), and in human talent or capital. Investing in the United States' human capital and innovation is not a new phenomenon. According to Gelbrich (1999), "the establishment of land-grant institutions was the first time the federal government ventured into funding and attempting to shape the direction of higher education in the United States" (p. 2).

This Act was passed on July 2, 1862, which made it possible for new western states to establish colleges for their citizens (United States Department of Agriculture [USDA], 2009). This federal policy established land-grant institutions that emphasized agricultural and mechanical arts. They became known as A&M colleges. On August 30, 1890, a second Morrill Act provided a more complete endowment and support of the colleges for the benefit of agriculture and the mechanical arts with the proceeds from the public land (United States Department of Agriculture, 2009). Louisiana State University, Mississippi State University and Texas A&M University are just three examples of institutions that have benefited from financial support extended to them by Morrill Land-Grants (Thattai, 2001). The Morrill Land-Grant Act is one example of a major contribution to education in America. According to Key (1996), the significance of the

Morrill Land-Grant Acts should not be overlooked. It was in effect "an important piece of federal economic policy" (para.7).

U.S. Paradigm Shift from Mechanical to Technological

As the United States moved from a mechanical-driven to a technology-driven society, the demand for a STEM educated and skilled workforce drastically increased. During the Sputnik era of the 1950s, the Federal government invested heavily in STEM fields. It established both the National Science Foundation (NSF) and the National Aeronautics and Space Administration (NASA) to compete with the scientific rigor of other countries, mainly Russia (Nealy, 2008).

White and Glickman (2007) further emphasized the following:

> Higher education continues to evolve worldwide. From the origination of Plato's Academy in ancient Greece, to the founding of Oxford's University College in 1249 A.D., to the legislation for land grant universities in the United States through the Morrill Act of 1862, up to the advent of online degree programs in the late twentieth century, the landscape in higher education has been constantly changing. While this evolution has led to the expansion of higher education industry and advancement in educational aspirations and attainment, ongoing improvement in these dimensions is imperative. (p. 98)

Education has been a key component in preparing a skilled STEM workforce. However, according to Tapia (2008), in the mid-1960s, the nation's research universities allowed very few minorities to gain admissions to the nation's top science and engineering institutions. Exceptions included Historically Black Colleges and Universities (HBCU's), MIT and other select institutions. It was during this same time frame that affirmative action was born. Supporters of equal rights began to use affirmative action policies to raise minority participation in higher education. Although URM participation in STEM continued to progress slowly, demands for a STEM workforce continued to rise steadily along with STEM innovation.

In the last 50 years, more than half of America's sustained economic growth has been fueled by engineers, scientists, and advanced-degree technologists (Schultz, Metz, Lowes, McGrath, & McKay, 2008). Scientific innovation has produced more than half of all U.S. economic growth (National Science Foundation, 2004). From microwave ovens to microchips embedded in handheld computers and Bluetooth technology, mobile telephones and nanotechnology; from curing polio to eventually curing cancers and H1N1 (Swine) flu, STEM innovation has made the lives of U.S. citizens richer, more productive, and more promising (Thompson, 2004). Increasingly, workers educated and skilled to fill positions in STEM fields have become essential to U.S. economic competitiveness, scientific leadership, national security, health, and the industrial base (Aerospace Industries Associations National Security Council, 2008). However, as the demand for a STEM educated workforce increases, the United States faces severe STEM shortages. While there are several variables that contribute to the nation not having the STEM educated and skilled human capital to meet its workforce demands, the following are the major reasons identified throughout the literature:

- In the wake of September 11, 2001, H1-B visa processes have been tightened and are harder to obtain. A limit of 65,000 visas per year has been set by Congress (United States Citizenship and Immigration Services, 2009). Additionally, "the United States produced a total of 122,450 engineering and science graduates in 2007, but less than two-thirds are eligible for high-level security clearances based on citizenship" (Aerospace Industries Associations National Security Council, 2008, p. 4).

- As other countries expand their STEM-related economic growth and become more developed, foreigners with STEM expertise who might have sought employment opportunities in the U.S. are able to find good jobs closer to or within their borders, while others are returning to their countries as contributors to STEM advancements and controllers of intellectual properties (United States Department of Labor, 2007).
- Large numbers of Caucasian males with jobs in STEM are on the verge of retirement (Burke and Mattis, 2007). One example is that nearly 70% of the civilian scientific and technical workforce at the Department of Defense (DOD) could be eligible to retire in seven years (Jackson, 2007).
- According to BEST (2004) "Our failure to act on the talent imperative could erode national innovation capabilities, increase the migration of high-wage science and engineering jobs overseas, dislocate the economy if inflows of international talent are reduced, and undercut public support for U.S. research and development" (p. 7).
- Women are underrepresented in the STEM workforce and those that are employed earn less when compared to men. Men outnumber women (73% versus 27% overall) in all sectors of employment for science and engineering (National Science Foundation, 2007).

- Minorities are underrepresented in STEM education programs and in the STEM workforce. By minority status, only 9% of all first-time STEM freshmen were African-Americans, only 7% were Hispanics, and only 1% were Native Americans in contrast to 83% of Caucasians and Asian-Americans (Tan, 2002). Additionally, under-represented minorities in STEM fields experience the highest attrition rates of 44% compared to Asian students at 26% and Caucasian students at 25% (Bonous-Hammarth, 2000). While strides have been made to address this shortage, more URM must be educated and skilled to enter the STEM workforce.

Equipping under-represented minorities to persist, to be retained, and to thrive in STEM disciplines will prove beneficial in developing a U.S. talent pool and contributing to productivity. Barrett (as cited in Business Roundtable, 2008) shares that "America's economic future lies with its next generation of workers and their ability to develop new technologies and products. This means we must strengthen math and science education in the U.S." (p. 8). STEM education must be a priority among a coalition of stakeholders from government, business, academia, workforce development entities, nonprofits, policy makers, and others (Aerospace Industries Associations National Security Council, 2008). Tapia and Johnson (2006) assert that a large amount of talent is wasted by not providing adequate research and investments for URM to become prepared and enter the STEM workforce. This lack of URM participation does not fill the needs or demands of organizations that require STEM skilled employees.

Leaky Pipeline and Under-Represented Minorities in STEM

Burke and Mattis (2007) inferred that the reason for the underrepresentation of minorities in STEM is multifaceted and exists at several levels. These levels include the individual (emotional stability and assertiveness), the family (educational level and financial support), the educational system (academic rigor and classroom climate), the workplace (wages and promotion), and society at large (policy and awareness). Subsequently, action strategies and solutions must address each of these levels to adequately begin to repair the "leaky pipeline," which is defined as the process by which URM students leave STEM fields (Blickenstaff, 2005, p. 369). If college students in STEM are the essential conduits to bringing about new and innovative scientific knowledge to enhance U.S. leadership in the global market, the pipeline issue of student entry into post-secondary education (PSE) along with persistence through graduation must be paramount (Tan, 2002). For minorities, accessibility of higher education has not resulted in high levels of degree attainment in STEM. Of the 166,530 STEM graduates, URM constitute roughly 7.3% or 12,157 of the projected 2011 class (National Center for Education Statistics, 2008). "Such a small number of under-represented minorities who graduate in STEM disciplines are but vapor when considering their overall and projected increase in higher education" (D. Yanez, personal communication, April 18, 2010).

While researchers have addressed the need to better prepare students for individual success, focus on structural changes as it relates to the "pipeline" should not be overlooked.

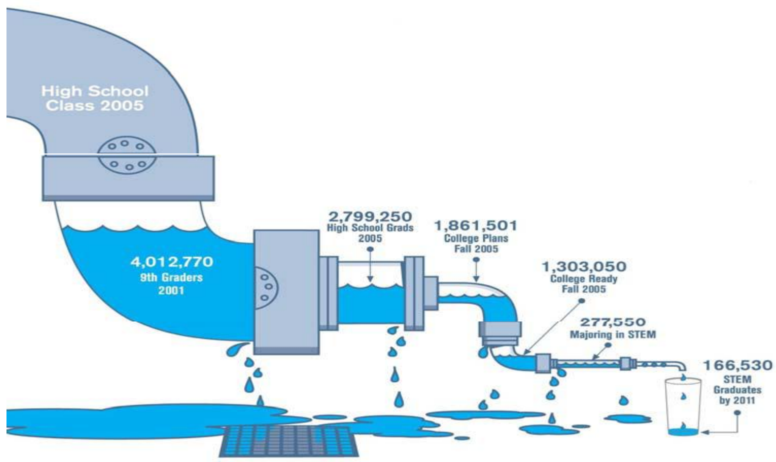

Figure 2. Leaky Pipeline (National Center for Education Statistics, 2008).

According to the by the National Science Board (2010) asserts, “the United States has become increasingly dependent on importing STEM talent from other countries rather than expanding the STEM pipeline from our own domestic talent pool” (p. vii). One of the challenges presented in the educational literature highlights the need for structural changes in the pipeline. “The emphasis on recruiting and retaining women and people of color in the pipeline encourages intervention strategies that enable students and faculty to fit into, adjust to, and negotiate the existing system, rather than challenging structures that currently exist” (Level Playing Field Institute, 2005, p. 19). Two advocates for structural change noted in the literature include the Sloan Foundation and the Howard Hughes Foundation: The Sloan Foundation supports the need for creating environments, which are established by institutions and faculty that nurture minority student success. The Howard Hughes Foundation supports funding for teaching and diversity at the institutional level.

Increasing the number of URM through recruitment and retention as a step towards progress introduces a critical mass theory, “which suggests that as a group’s presence and level of participation grows, at a particular point, the perspective of members of the minority group and the character of relations between minority and majority changes qualitatively” (Level Playing Field Institute, 2005, p. 18). Adelman (2006) advocates that:

> There is no linear path to a degree. The default pipeline metaphor…is wholly inadequate to describe student behavior which moves in starts and stops, sideways, down one path to another and perhaps circling back. Liquids move in pipes; people don’t. (p. 107)

Researchers argue that targeted programs are necessary, but must joined with structural change that will eventually make targeting unnecessary.

Education, the Workforce, and Under-Represented Minorities in STEM

After World War II, the numbers of students attending college increased significantly. America led the way in educational attainment by massively increasing educational enrollments at the elementary, secondary, and post-secondary levels (Toulmin & Groome, 2007). This period of innovation introduced new products and processes, which significantly expanded America's economic base, created jobs, and gave the United States an advantage against foreign competitors (Lips & McNeill, 2009). STEM educated and skilled workers became the critical brainpower and engines of innovation to economic growth in the U.S. market. Remarkably, individuals working in these STEM fields make up a small percentage of the workforce, but contribute greatly to the economic growth and development of the nation. According to BEST (2004), while only about 5% of America's 132 million workforce is employed in STEM fields today, this fantastic 5%, as they are referred to in the article, accounts for more than 50 % of the nation's sustained economic growth (p. 1). In addition, the landmark 2005 report, *Rising above the Gathering Storm*, projected that over 85% of U.S. economic growth per capita has been the result of technological change (National Science Foundation, 2005). However, minority participation remains at a very low level as the demand for STEM talent overall continues to escalate.

As aforementioned, a report from the National Action Council for Minorities in Engineering (2008) reveals that the already low percentage of minority students pursuing STEM degrees and careers has reached a plateau and even declined in recent years. For example, 2,982 African Americans, 4,136 Hispanics, and 308 Native Americans received baccalaureate degrees in engineering out of a total of 60,639 minority graduates in 2002, according to data from the Commission on Professionals in Science and Technology (CPST). Michelle Cooper (2009), president of the Institute for Higher Education Policy, also surmised there is no single solution to the problem of underrepresentation of minority students in STEM disciplines. Nonetheless, it is imperative that the nation makes educational success of URM in STEM fields a priority. Strategic investments in STEM education and diversification can have a tremendous effect on the erosion of the U.S. preeminence in the science and technology marketplace (Cooper, 2009).

Chubin et al. (2005) suggest that it is better to think of diversity as an asset, an enabler that makes teams more creative, solutions more feasible, products more usable, and citizens more knowledgeable. "Diversity arguably makes any profession, but especially science and engineering more competent" (Chubin et al., 2005, p. 1).

Additionally, Slaughter and McPhail (2007) articulated that diversity drives innovation and its absence imperils designs, penalizes products, and limits creativity. Some of the benefits of preparing URM for STEM disciplines include: (a) tapping into the resources that can provide for multiple perspectives and advancements in STEM in America, (b) enhancing the quality of decision making in policy, and (c) allowing for more diversified viewpoints that can add to a better understanding of science and technology.

In contrast to what is shown in much of the literature, the Center for College Affordability and Productivity (2008) suggests a different perspective as it relates to STEM shortages. It documented that the perceived shortages of qualified personnel for STEM jobs is most likely a case of increased demand rather than a relative decline in degree supply overall. On an annualized basis, growth in bachelor degrees awarded in the STEM disciplines has kept pace with degrees awarded in the non-STEM disciplines. According to the Center for College Affordability and Productivity (2008), the percentage of students graduating with degrees in STEM has remained relatively constant over the past three decades.

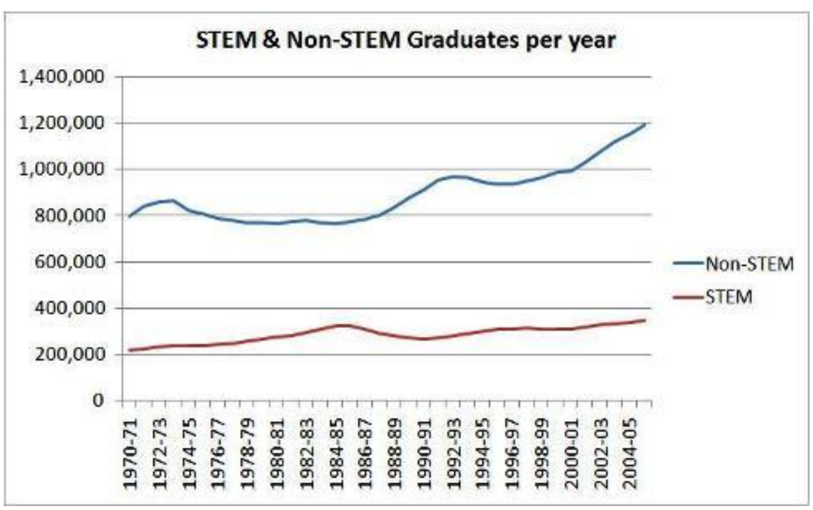

Figure 3. STEM & Non-STEM Graduates Per Year (Center for College Affordability and Productivity, 2008).

A report on a 2009 survey by the Higher Education Research Institute at UCLA (2010), illustrates that when compared to Whites and Asians, URM were nearly identical in their proportionate interest in STEM. Thirty-four percent (34%) of URM students and 34.3% of White and Asian American students indicated that they planned to pursue a STEM major (Higher Education Research Institute at UCLA, 2010). However, the Higher Education Research Institute at UCLA (2010) also documented the following for STEM degree completion rates for 2004 freshman STEM degree aspirants who completed their degrees in 2008 (4 years) and 2009 (5 years):

> White and Asian American students who started as STEM majors have four-year STEM degree completion rates of 24.5% and 32.4% respectively. In comparison, African American, Hispanics, and Native American students who initially began college as a STEM major had four-year STEM degree completion rates of 13.2%, 15.9%, and 14.0%, respectively. The difference between White and Asian American STEM majors and their URM counterparts is even more pronounced when considering five-year STEM completion rates. Approximately 33% and 42% of White and Asian American STEM majors, respectively, completed their bachelor's degree in STEM within five years of college entry. In contrast, five-year STEM completion rates for African American, Hispanic, and Native American students were 18.4%, 22.1%, and 18.8%, respectively. (p. 2)

Figure 4 highlights the 4-year and 5-year STEM degree completion rates for White and Asian students as compared to African American, Hispanic, and Native American students, for students included in the UCLA study.

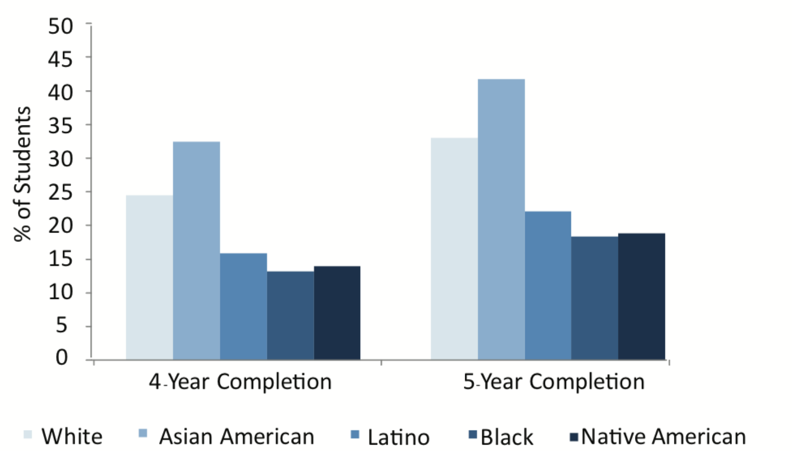

Figure 4. Percentages of STEM Degree Completions, 4-Year and 5-Year (Higher Education Research Institute at UCLA, 2010).

More under-represented minorities must be educated and trained in order for the United States to develop increased human capital to help meet its STEM workforce demands (Thompson, 2004) as well as to contribute to future projections. An even greater rationale for increased STEM diversity is the need to improve and augment the quality of new perspectives to the STEM enterprise in both research and the overall workforce (BEST, 2004; Jackson, 2003; Leggon & Malcom, 1994). More URM students should be educated to help meet the increasing STEM demand and to help ensure more U.S. innovation, productivity, and global competitiveness.

The United States Bureau of Labor Statistics (2006) has predicted significant growth in the need for an overall STEM workforce by 2014; of the 20 fastest-growing occupations in the near future, 17 will be in health care and computer fields. Moreover, the Bureau of Labor and Statistics (BLS) reported that 2.5 million STEM workers will be needed to fill vacancies occurring in the 10-year period of 2004-2014 across all industry sectors (Aerospace Industries Association's National Security Council 2008). The United States Bureau of Labor Statistics completed a breakdown of the increases in the STEM workforce industry sectors, which included the following; a 15% job growth in science; a 31% job growth in technology; a 12% job growth in engineering; and a 10% growth in mathematical sciences (Aerospace Industries Association's National Security Council, 2008).

As the STEM workforce demands have increased, so has the overall college enrollment over the past forty years. Undergraduate enrollment overall increased during the 1970s, "dipped between 1983-1985, increased 18% from 1985-1992, declined 2% and then stabilized between 1993-1996, and has since rose 25% between 1997-2007" (National Center for Education Statistics, 2009, p. 1). According to Slaughter and McPhail (2007), URM enrollment in undergraduate studies is expected to increase to 32% in 2010 and to 38% in 2025, respectively. However, when it comes to STEM disciplines overall, White (2005) argues that interest has been declining on college campuses since 1967. Interest, access, and persistence have been a challenge for URM students, who accounted for only 12% of the total STEM degrees awarded in 1998 (Nestor-Baker & Kerka, 2009; White, 2005).

In 2000, Caucasians represented 82.3% and Asian Americans represented 10.4% of the STEM workforce, while African American, Hispanics, and Native Americans were 3.4%, 3.1%, and 0.3% of the STEM workforce, respectively (Bonous-Hammarth, 2000, p. 92). The National Science Foundation, National Science Board (2006) reported that bachelor degrees earned by URM in STEM fields accounted for a total of 16% compared to Caucasians at 66%. As aforementioned, a gap between minorities and Caucasians in degree attainment remains large in general and even larger in STEM fields. Richardson and Santos (1988), inferred that if the United States does not adequately invest in and develop its under-represented minorities in STEM disciplines, it will be contributing to a "national failure that undermines the foundations of a free society, interferes with efforts to build a more competitive workforce, and raises doubts about America's educational system's capacity to respond to demographic, economic, and technological changes (p. 1)." Mackie (2008) further emphasized the following:

> If the country, its leaders and teachers fail to prepare and equip citizens from all population groups to participate and succeed in the present and future knowledge and technology driven economy, we risk undermining our own demise on the world stage, economically and intellectually. (p. 5)

The United States Department of Labor (2007) reported that U.S. competitiveness in STEM fields requires STEM qualified and skilled workers. This ranges from the most complex research and development and leadership positions to production, repair, marketing, sales and other jobs that require competencies built upon STEM knowledge (United States Department of Labor, 2007). Getting more Americans ready for, interested in, and sufficiently skilled to be productive in STEM-related jobs requires attention to segments of the workforce that are often overlooked in STEM discussions. Included in these segments are incumbent workers who need specific skill upgrading and competencies, dislocated workers who are trying to find new jobs in industries with more secure employment opportunities, and under-represented minorities in STEM disciplines (United States Department of Labor, 2007). The National Science Board (2010) asserts if the United States is to ensure long-term prosperity; it must renew a collective commitment to excellence and high expectation in education and the development of more of its human capital and scientific talent.

It is essential that America acts now to ensure all of its students can continue to prosper in the 21st century technology-based economy (Beering, 2009). The National Science Foundation (2006) contends that it is imperative that the number of domestic students from all demographic groups, including URM students are recruited and prepared in proportion to the nation's need for them in STEM areas. The value and role of human capital must not be taken lightly as it relates to STEM demands.

Throughout their lifetimes, students accumulate assets in the form of knowledge, cultural, and social experiences that when combined constitute their human capital (Nettles & Millett, 1999). Gilmore (1999) defines human capital as the physical and intellectual skills and capabilities that enable an individual to perform tasks effectively and lead a productive life. According to the Aspen Institute (2009), thinking and acting strategically about human capital development and management is the lifeblood of most high-performing businesses and organizations. "Increasing the regional capacity for human capital generation and utilization may be one of the most important regional development policies for success in the future high technology economy " (Gilmore, 1999, p. 1).

Because of the shortage of qualified American workers in STEM fields, several foundations are conducting in depth studies to investigate possible solutions for the shortages in the U.S. STEM workforce crisis. In 2006, the National Science Foundation (NSF) released a publication entitled, *Rising above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future.* This report concluded that there is a need to increase the number of URM students enrolling in and graduating from undergraduate and graduate STEM fields. Increasing URM participation is critical to ensuring a higher-quality supply of scientists and engineers in the United States over the long term. If some groups are underrepresented in science and engineering, then many talented people are not being attracted to and retained in an important segment of the knowledge economy (National Science Foundation, 2006).

URM students accounted for only 12% of the total STEM degrees awarded in 1998 (Nestor-Baker & Kerka, 2009; White, 2005). As the percentages of URM students continue to increase in undergraduate studies, persistence and retention of more URM students in STEM disciplines is a part of the solution to filling a real gap in the U.S. workforce. As the demand for STEM related occupations drastically increases across the globe, the nation must take advantage of this opportunity to prepare and recruit URM students in STEM disciplines. Increasing participation of URM students is critical to ensure that the United States has a pool of highly qualified and trained scientists and engineers. If URM students continue to be underrepresented in science and engineering fields, then many ideas from a diverse segment of the new high-tech economy is not included (National Science Foundation, 2006). This would result in the continuation of less diversity in STEM disciplines, workforce shortages, partial educational investment in the nation's STEM talent pool, and not the full use and development of viable U.S. human capital.

Several reports have indicated a move in U.S. initiatives to expand the nation's scientific, engineering, and technical workforce (Center on Education and Work, 2008). In his November 23, 2009 educational address, President Barack Obama shared that there is a necessity to increase the STEM knowledge of today's students in order for them to become tomorrow's leaders in innovation. President Obama further emphasized that there is a mandate for science-savvy citizens to help decide STEM policy. In addition, he addressed three overarching priorities as it relates to STEM education: "(a) increasing STEM literacy so that all students could have more critical thinking skills in this area, (b) improving math and science teaching to enhance students' STEM educational levels to compete globally, and (c) expanding STEM education and career opportunities for underrepresented groups, including women and minorities" (White House Office of the Press Secretary, 2009, p. 1).

Models of Persistence and Retention

As the United States seeks to increase its under-represented minority talent pool, multiple theories of student departure from college have been developed (Seidman, 2005) and several theoretical models have evolved in the areas of persistence and retention.

These theories evolved from various disciplines and include studies based on psychological (Brower, 1992; Stage, 1989), organizational (Bean, 1980, 1982), economic (Cabrera, Stampen, & Hansen, 1990; St. John & Noell, 1989), and sociological (Rootman, 1972) research. However, theories that have remained in the forefront of the literature and sustain academic attention are clearly more research based (Rich, 2009; Seidman, 2005). While all too many theories look at student deficiencies as it relates to college, there are some whose focus is more on factors that contribute to student success.

Tinto's (1973, 1993) and Astin's (1970) models address the areas of persistence and retention from the perspectives of student departure and inclusion, which are still being used today. Ford-Edwards (2004) contends that most studies on retention have been quantitative in design and have viewed undergraduate student retention from a "deficiency" perspective; in terms of what students are lacking, or institutional variables that cause students to “dropout” or “withdraw” (Bean, 1985; Braunstein, McGrath & Pescatrice, 2000; Cabrera, Castaneda, Nora, & Hengstler, 1992; Ford-Edwards, 2004; Jackson & Swan, 1991; Nora, Attinasi, & Matonaki, 1990; Pascarella & Terenzini, 1991; Tinto, 1975, 1987, 1993).

Instead of a re-examination of these factors, this study has been designed to probe primarily in an area that needs more attention, for example, factors that contribute to persistence and retention of URM in STEM disciplines. Amidst the emphasis on students’ failures and departures, more studies that focus on students’ successes are needed.

Only within the past fifteen years has there been more focus on what successful students do to persist in college. It is pleasing to see that a growing number of educational researchers such as Padilla (1999), Gandara (1995), and Rendon, (1994) have been examining student persistence and retention from the viewpoint of successful students (Gandara, 1995; Hurtado, 1994; Rendon 1994). There is a great deal to be learned from the perspective of what successful students are doing to navigate post-secondary education (PSE) and STEM disciplines.

This section of the review of literature begins with Tinto’s Interactionist Model of College Student Departure (1975, 1987, 1993) and Astin’s (1984, 1985) Input-Environment-Outcome Model of Involvement, which are discussed in detail. Additionally, Padilla’s (1999) Local Expertise Model of Minority Student Success has been synthesized and critiqued as it relates to student persistence and retention. Padilla’s research specifically focuses on successful minority students in PSE. These models of Tinto, Astin, and Padilla provide the theoretical framework for this study.

Tinto's Interactionist Model of College Student Departure

One of the most studied areas in higher education has been student persistence and departure (Braxton, 2000; Tinto, 1993). Tinto's (1975, 1987, 1993) model of student departure, referred to as an interactionalist approach, is probably the most recognized in the higher education sector (Tillman, 2002). The origins of Tinto's student departure theory began in 1973 through collaboration with Cullen (Metz, 2002). Cullen and Tinto produced a theoretical model of attrition and persistence, which included the following: (a) pre-entry attributes, (b) institutional experiences, (c) integration, (d) goals and commitment, and (e) outcome (Metz, 2002).

Tinto's subsequent inclusion of additional environmental variables was adapted from Van Gennep's (1960) rites of passage theory. Tinto uses Van Gennep's theories about rites of passage to explain the process by which students transitioned from high school into college. He posits, "The point in referring to the work of Van Gennep is that it provides us with a way of thinking about the longitudinal process of student persistence in college and by extension, the time-dependent process of student departure" (Tinto, 1987, p. 442). According to Metz (2002), Van Gennep's theory incorporated fundamental sociological perspectives previously identified by Emile Durkheim (1953), the famous French sociologist. Later, Tinto also expanded the research of Spady (1970, 1971) who adapted his theory of student departure and based his work on Durkheim's theory as well (Carter, 2006). Tinto's models have contributed solid foundations for research as it relates to student retention and departure.

Tinto postulates involvement as critical in students' process of college persistence (Milem & Berger, 1997). He asserted that the process of becoming integrated into both the academic and social systems of college occurs when students successfully navigate three stages. The stages or passages identified in the literature are separation, transition, and incorporation. Separation involves students' ability to disassociate themselves within reason from the norms of past communities. Such may include, but is not limited to, families, high school friends, and other local ties that demand time and energy. This is a challenge for many under-represented minorities because of their closeness to family and community. Family background plays a pivotal role in students' success and goal attainment, particularly for minority students (Bonner, 2003; Guiffrida, 2005). A plethora of studies have established the significance of keeping connections to cultural heritage for minority students who gain support from both families and communities (Guiffrida, 2005; Kuh, 2005).

The next phase, according to Tinto, is transition**.** It is described as a "period of passage between the old and the new, between associations of the past and hoped for associations with communities of the present" (as cited by Bolle, Wessel, & Mulvihill, 2007, p. 444). In transition, students have separated themselves from the norms and patterns of their past lives but have not yet adopted norms and behaviors from their new environment. This stage can be stressful, and an identity crisis can occur as students feel overwhelmed and, according to Tinto (1988), torn between what they left behind and "the patterns of behavior of the past and those required for incorporation into the life of the college [environment]" (Bolle, Wessel, & Mulvihill, 2008, p. 1).

Finally, incorporation occurs when students adapt to what Tinto referred to as the established norms and behavior patterns of their college or university setting. Once incorporated, the students become integrated into the new environment. Nevertheless, successful integration does not ensure persistence.

Tinto posits that students' involvement with campus environments influences perceptions of both institutional and peer support. Students’ perceptions as to how they are being supported affect the levels of subsequent involvement on campuses during future semesters in college (Tinto, 1993). He articulated that behavior as established by involvement affected subsequent levels of institutional commitment, which has been shown to have an effect on students’ departure or persistence (Tinto, 1993). However, this theory has not gone without challenge especially as it relates to URM in college.

Guiffrida (2005) differs with Tinto in particular concerning the need for “separation” in order to have successful integration. Tinto posits that students must separate at a reasonable level from their families to become a more integrated part of the college environment. However, Guiffrida (2005) contends that the application of this model to URM students is unsuitable. According to London (1992), a great challenge facing URM students in obtaining a college degree is being torn between two cultures. They include the old culture of their friends and family and the new culture of their college community (London, 1992). Hsiao (2000) contends that while going to college may be viewed as a rite of passage for any student, it is seen as a significant separation from the past (e.g., family, friends, and community) for students who are the first in their families to enter the college domain. In 2000, the National Center for Education Statistics reported that roughly 43% of first-generation students who entered PSE left without obtaining a degree. Sixty-eight percent of students whose parents were college graduates completed a bachelor's degree. Hsiao (2000) emphasized that the traditional university is based on Eurocentric frameworks that tend to differ from the cultural backgrounds and norms of minority students (Guiffrida, 2005). Furthermore, Holmes (2007) suggested "the competitive learning styles of the dominant European Anglo-Saxon culture, on which the United States educational system is built, make assimilation very difficult for minority students whose learning styles are often more collaborative in nature" (Rich, 2009, p. 19).

Astin's Input-Environment-Outcome Model of Involvement

Whereas Tinto emphasizes that inclusion is a key factor in student persistence and retention, Astin places major emphasis on student involvement. Astin's (1984) theory of involvement focuses on the issue of college persistence and is among the most widely cited approaches in the higher education literature (Milem & Berger, 1997). Astin's model of student involvement evolved from his longitudinal study of factors that contributed to persistence along with some of Pace's (1984) research, which focused on student effort (Rich, 2009). Astin articulated that student involvement is a key ingredient in college persistence. Astin (1983) defined student involvement as "the amount of physical and psychological energy a student devotes to the academic experience" (p. 134).

Some of the characteristics of highly involved students include active participation in student organizations, devotion of vast amounts of energy to the discipline of studying, and frequent interaction with faculty members and other students, all of which contribute to social and academic development. Astin described such involvement as behavioral and concluded that it is not solely based on what the individual thinks or feels, but more on what the individual does, which defines and identifies involvement (Astin, 1985, p. 135) and it is considered to be critical in the literature. Research overwhelmingly suggests that students who are academically and socially involved are more likely to persist (Tinto, 1988).

In his book, *Achieving Educational Excellence*, Astin identified five basic postulates in the involvement theory. Astin contends that involvement equates to the investment of physical and psychological energy in diverse objects that may differ from generalized to specific in order to accomplish an academic goal. He further posits that involvement develops along a continuum with different levels of student participation towards different objects and at different times and can be measured both qualitatively and quantitatively. Astin emphasizes that student learning and personal development in educational programs relate directly and proportionately to the quantity and quality of student's involvement. He also suggests that the effectiveness of any educational policy or practice is measured by its ability to increase student involvement (Astin, 1985, pp. 135-136).

Astin's theory of student involvement has important implications for the skill of teaching. According to Hunt (1980), faculty members need effective pedagogy when carrying out teaching activities. Astin (1985) further emphasizes, "when faculty members and administrators are aware of the theories that guide their actions, they seem to accept them as gospel rather than as testable propositions" (p. 520). Three pedagogical theories that Austin detailed are the content, the resources and the individualized theories (Astin, 1985).

The content theory. According to this theory, students learn by being primarily exposed to the right subject matter (Astin, 1985). For example, students are exposed to information usually written in a course syllabus. Practitioners hold course content in the highest regard and expect students to comprehend and obtain the material mainly through lectures, reading assignments, and studying in the library. However, connectedness is essential for more minority success, and faculty involvement has shown to be a key factor for URM in PSE. Often high prestige is given to professors who are viewed as subject matter experts. These individuals may not have additional time to invest in fostering students needs based on speaking engagements, publications, the need to meet high demands for their expertise. Austin (1984) inferred that “this approach appears to encourage the fragmentation and specialization of faculty interests and to equate scholarly expertise with pedagogical ability” (p. 252). Content theory has a serious limitation as noted in the literature. Students are identified as “passive learners” who are avid or good readers, and are intrinsically motivated perform better academically (Astin, 1984, p. 520).

The resource theory. The term resource theory refers to a vast array of assets believed to enhance student learning and development. Examples include guidance counselors, technology labs, state of the art libraries, financial aid, and well-trained faculty members. Astin contends that college administrators and policy makers place a high priority on the acquisition of resources (Astin, 1985, p. 138).

A low student-faculty ratio is highly regarded by administrators as a key resource. Astin suggests that too often institutions try to increase the number of “high-quality” professors perceived to be ranked high in scholarly productivity and national visibility in order to strengthen their educational environment. He further notes “having successfully recruited a faculty "star," the college may pay little attention to whether or not the new faculty member works effectively with students" (Astin, 1985, p. 521).

The individualized theory. This theory has been identified as more of a stand-alone model because it did not evolve directly from the traditional views and is not bound by them. Essential conduits to students' success in this theory include counseling and advising as well as independent study. Examples of instructional techniques in the individualized approach include self-paced instruction and contract learning. The model of competency-based learning, additionally mentioned in Vorhees's (2001) research, while not exhaustive, supports the individualized theory (Astin, 1985). While individualized theory is interesting, Astin documented that it is hard to put into practice.

Of the factors likely to increase student involvement; Astin (1985) asserted that one of the most important is students' residence. He noted that living on campus enhanced student retention among all types of students regardless of their races, abilities, or family backgrounds. Furthermore, Astin's (1975) longitudinal study posited that students who joined social fraternities or sororities or took part in extracurricular activities were less likely to drop out of school. Examples of other student activities shown to enhance retention and positively affect persistence include participation in the following: intercollegiate sports, honors programs, ROTC, undergraduate research projects, as well as having a Work-Study job or working on campus.

In developing the theory of student involvement, Astin emphasized his dissatisfaction with research that tended to treat the student as a "black box." Astin's (1985) dissatisfaction with the implicit ideas about teaching and students being compartmentalized led to his use of the term "black box." He articulated that at the input end of this "black box" are the different programs and policies of colleges or universities. On the output end are different types of achievement measures. Examples of products at "output end" include grade point average and scores on standardized tests such as the ACT. In further examining the "black box" that Astin addressed, he mentioned "what seems to be missing is some mediating mechanism that explains how educational programs and policies can be translated into student achievement and development" (p. 520). Padilla (1999) also used the concept of a "black box" to describe the campus experience where very little or nothing at all is understood about what happens between inputs and outputs (Padilla, 1999). Astin and Padilla emphasized the need for understanding "what happens between these two temporal points," for example, entering (input) and leaving (output) college (Padilla, 1999).

Padilla's Local Expertise Model of Minority Student Success

Padilla's model has been chosen because of his specific research on minority students' success and its practical relevance to this study in the area of persistence and retention. According to Padilla's Black Box Theory (1999), colleges and universities have environments composed of barriers that students must successfully navigate in order to earn a degree. Padilla's expertise model focuses on the knowledge that successful students have and the actions they employ to overcome educational barriers (Padilla, Trevino, Gonzales, & Trevino, 1997). He contends that a student's ability to succeed "depends on the salience of each individual barrier for a given student and that student's ability to overcome a particular configuration of barriers on a given campus" (Padilla, 1999 p. 135). Below is a graphic of the Black Box Theory approach as defined by Padilla.

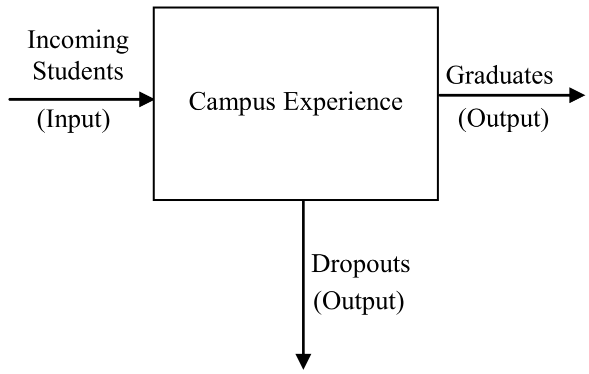

Figure 5. The "Black Box" Approach to the College Experience (adapted from Padilla, 2001).

Padilla (1998) articulated:

> While it is necessary to understand why some students fail to complete their programs of study so that students and institutions can be told what to avoid, it is crucial to understand what accounts for students' success when they do complete a degree program so that students and institutions can be told what to do. (p. 2)

Padilla's model is based on the results of qualitative research and on Harmon and King's Expert Systems theory (Harmon & King, 1985; Padilla, 1992). In this model, Padilla contends that successful college students are those who become "experts" at being successful as students at a particular college or university (Padilla et al., 1997). Padilla (2001) emphasized that in spite of facing barriers such as a lack of minority support, a lack of financial aid, and a lack of cultural sensitivity, successful students are able to navigate such barriers and matriculate towards graduation.

He presents two major forms of knowledge formulated on the theory of Harmon and King: theoretical and heuristic. Theoretical knowledge is defined as book knowledge, which is learned on campus through coursework and formal study and is more abstract (Padilla, 1992). Heuristic knowledge is defined as a specific argument derived from experience and is more concrete (Padilla, 1992). Padilla (1992), along with Harmon and King (1985), articulated that theoretical knowledge without heuristic knowledge is insufficient for students' success.

Padilla (2001) argued that all students arrive on campus with certain levels of theoretical and heuristic knowledge. He further adds that upon entering PSE and during their tenure, students are challenged by the institutions in which they are enrolled, to demonstrate increased levels of theoretical knowledge before degree attainment will occur (Padilla, 2001). Course completion and test performance represent the standards of measurement or assessment used most frequently to determine theoretical knowledge. However, the expertise model also suggests that students must acquire and apply a certain amount of heuristic or practical knowledge early to successfully navigate the college experience. Examples given in the literature of this type of knowledge include the following: (a) knowing when and where to get a tutor, rather than getting too far behind in a course; (b) knowing when to drop a class so as to not fail a course; and (c) knowing how to monitor deadlines needed for the filing of forms in order to obtain grants and loans. These examples of heuristic knowledge are critical to student persistence and retention (Harmon & King, 1985; Padilla, 1992).

According to Padilla (1992) and Harmon and King (1985), heuristic knowledge is not usually taught to students in a formal manner. It is important to note that he further emphasized that heuristic knowledge is not significantly generalizable from one campus to another. Padilla contends that experienced students informally pass along heuristic knowledge to new students on an individual basis or organizations pass it on to new students in groups (Padilla, 1993). Students who fail to gain enough heuristic knowledge are not likely to complete their degrees. Padilla's focus on both theoretical and heuristic knowledge and how successful students acquire and apply these forms of knowledge have some commonalities with what is referred to as cultural capital. "In addressing the debate over knowledge within the context of social inequality, Pierre Bourdieu argued that the knowledge of the upper and middle classes are considered capital valuable to a hierarchical society" (Yosso, 2005, p. 70). Padilla's heuristic knowledge and Bourdieu's capital cultural appear to share some commonalities as it relates to students' persistence. According to Yosso (2005), Bourdieu's work has often been called upon to explain why URM do not succeed at the same rate as Caucasians in education.

Bourdieu coined the phrase "cultural capital" as awareness and fluency in a society's elite culture. He viewed cultural capital as a socially valued knowledge of cultural cues developed in the lives of youth, which was part of the influence of their well-educated parents or well-to-do members of society. Such knowledge expands into secondary institutions and plays a significant role in helping students who have cultural capital at varying levels and use it to transition into and through college life and experiences. Cole and Espinoza (2008) suggested, "cultural capital gained prior to students' college enrollment will significantly contribute to the academic success of these students" (p. 286). Hayes (2005) documents Bourdieu's forms of capital as follows:

> The term *cultural capital* represents the collection of non-economic forces such as family background, social class, varying investments in and commitments to education, which influence academic success. Bourdieu distinguishes three forms of cultural capital. The embodied state is directly linked to and incorporated within the individual and represents what they know and can do. Investing time

> into self-improvement in the form of learning can increase embodied capital. As embodied capital becomes integrated into the individual, it becomes a type of habitus and therefore cannot be transmitted instantaneously. The objectified state of cultural capital is represented by cultural goods, material objects such as books, paintings, instruments, or machines. They can be appropriated both materially with economic capital and symbolically via embodied capital. Finally, cultural capital in its institutionalized state provides academic credentials and qualifications that create a certificate of cultural competence, which confers on its holder a conventional, constant, legally guaranteed value with respect to power. (p. 1)

Swail, Redd, and Perna (2003) describe the process of biculturation whereby students “live simultaneous lives in two cultures, two realities” (p. 49). Troy Duster suggests a similar phenomenon as “dual competency” in that “students must be competent in their own culture plus the culture of the institution” (p. 49). Yosso (2005) challenges this school of thought with the following question. Does traditional cultural capital theory value or recognize the forms of cultural capital that marginalized groups bring to the table?

Elements of the Padilla model show particular relevance to the performance of under-represented minorities. Certainly, URM can benefit from the power that comes with possessing cultural capital as they pursue degrees in higher education. Padilla’s work represents some similarities to Bourdieu’s focus on cultural capital as it relates to student empowerment and success in college. Perrakis (2008) contends that, unfortunately too many low-income students enter college lacking the cultural capital required for successful assimilation into college life. According to Cox (2009), "lower-income students are much less likely to enroll in college than their more affluent peers; once enrolled, they are less likely to complete a degree" (p. 8).

Furthermore students from low socioeconomic backgrounds, where a good number of URM are categorized, may lack the cultural capital that enhances success in higher education if support systems are not in place. With regard to their academic performance, there is also the assumption that two major forces influence students: the cultural capital they bring to college, and the cultural congruity they perceive once in college (Cole & Espinoza, 2008).

Interestingly, according to Paulsen and St. John (2002), African American students enrolled at Historically Black Colleges and Universities (HBCUs) who were of low socioeconomic status had higher persistence than white students of low socioeconomic status. This is likely to be contributed to the "cultural capital" of HBCUs (Paulsen & St. John, 2002). Thus, there is a need to determine which culture, if any should set the standard for cultural capital. Sociologists Melvin Oliver and Thomas Shapiro (1995) contend that cultural capital is actually only one form of many different aspects that might be considered valuable when it comes to educational success.

According to Tinto (1993), about 60% of all students who leave college do so during their freshman year. This fact stresses the importance of attending to heuristic knowledge concerns as soon as the students arrive on campus, if not before. Key to the successful application of the expertise model is the assessment of heuristic knowledge both as an indicator of the barriers that students must overcome on a particular campus and also as a means for identifying the actual knowledge and actions that successful students use to overcome the barriers (Padilla, 1996). According to Padilla, unsuccessful students need heuristic knowledge to increase their chances of obtaining a college degree. Some programs are geared to enhance the development of heuristic knowledge and increase cultural capital in minority students, especially in STEM disciplines.

LSAMP and BEST, Innovative Practices That Promote URM Persistence and Retention in STEM

Over the last 20 years, there has been a proliferation of programs with a mission to improve and increase the participation of under-represented minorities in STEM fields. Many colleges and universities use cohort or bridge programs to promote student persistence and to enhance student success in STEM. According to the Business-Higher Education Forum (2010), by grouping students together in areas such as course sequence, smaller learning communities, affinity dorms, and other activities, cohort programs build strong student social networks. Furthermore, Nestor-Baker and Kerka (2009) contend that cohorts positively impact STEM graduates and are of a relatively low cost to implement. Bridge programs are typically offered during the summer after students graduate from high school and their first college semester. “Both types of programs have been shown to increase persistence, largely because they foster student engagement and social interaction, leading to a greater sense of connection to their programs and universities” (Business-Higher Education Forum, 2010, p. 9).

The National Science Foundation (NSF) is a major sponsor of bridge programs. NSF is an independent federal agency established by Congress in 1950. Its mission is to promote the progress of science; to advance the national health, prosperity, and welfare of the United States, and to secure the national defense (National Science Foundation, 2009). NSF has an annual operating budget of approximately six billion dollars and is the funding source for nearly 20% of all federally supported basic research conducted by America's colleges and universities (National Science Foundation, 2009). In fields, such as mathematics, computer science and the social sciences in particular, NSF is the major source of federal backing. Additionally, one of the programs sponsored by NSF is the Louis Stokes Alliance for Minority Participation (LSAMP) program. LSAMP is the umbrella program in which some of the participants in this study are enrolled.

Louis Stokes Alliance for Minority Participation (LSAMP)

LSAMP has been designed specifically to prepare more URM for STEM disciplines. It was developed in (1991) with the mission of increasing the quality and quantity of minority students who successfully complete baccalaureate degrees in STEM fields (Clewell, DeCohen, Tsui, & Deterding, 2006). LSAMP prepares URM students to enter graduate studies in STEM disciplines. Subsequently, LSAMP has the mission of not only increasing the number of URM in higher education but also to increase the number of URM serving in the diversification of the STEM workforce (Alliances for Graduate Education and the Professoriate, 2006).

The LSAMP program began with grants awarded by NSF to six multi-institution alliances across the country. The LSAMP program encourages alliances amidst leaders and stakeholders in academia, government, business, national research laboratories, as well as other local, state, and federal organizations (National Science Foundation, 2003). Currently, 34 Alliances with more than 450 participating institutions have produced thousands of STEM bachelor's degrees (Clewell et al., 2006). Opportunities for hands-on research experiences and mentoring are offered to participants in the LSAMP to enhance their interest, persistence, retention, and graduation.

Through these partnerships, LSAMP creates and sustains supportive environments that include adequate provision of financial and social support. Moreover, the program focuses on socializing students into STEM disciplines in particular. Socialization is clearly documented and supported in Tinto's (1975) research.

Since program evaluation is a critical component of program effectiveness and proficiency, LSAMP has been evaluated to gain a better understanding of its operation, to document its efficiency, and to examine its strengths and weaknesses. Recently, the program was evaluated by the Urban Institute, a Washington, DC-based think tank that analyzes policies, evaluates programs, and informs community development in order to improve social, civic, and economic well-being of Americans (Urban Institute, 2010). This evaluation had two parts: process, which highlighted how the LSAMP was implemented; and outcome, which focused on the extent to which LSAMP was meeting its stated goals. The Urban Institute (2005) evaluators concluded that LSAMP was indeed meeting the following goals: (a) student participants in LSAMP pursued post-bachelor's coursework; (b) they enrolled in graduate programs; and (c) they completed advanced degrees at greater rates than national comparison groups of other under-represented minorities, Caucasian, and Asian students (Clewell et al., 2006). According to Leggon (2006), almost 80% of LSAMP participants pursued post baccalaureate education, and 66% later enrolled in a graduate program to pursue a masters, doctoral, or professional degree. Another innovative STEM program is the Building Engineering and Science Talent (BEST) program.

Building Engineering and Science Talent (BEST)

Building Engineering and Science Talent (BEST) is a public and private partnership dedicated to building a stronger, more diverse U.S. workforce in science, engineering and technology by increasing the participation of underrepresented groups. BEST was formed in 2001 with seed funding from NSF, the DOD, NASA, Department of Energy, National Institutes of Health, Department of Agriculture and the Department of Commerce to address the challenge of developing more science and engineering talent. John Yochelson (2001), a veteran of the Council on Competitiveness, which is a non-partisan and non-governmental organization, spearheaded the effort with the help of industrial, educational and government leaders across the country. These leaders are organized as BEST's Board of Directors, National Leadership Council, National Research Board, three Blue Ribbon Panels, and Project Integrators.

According to Jackson (2002), framing America's problem pointed quickly to the source of America's solution even before the formation of BEST. Caucasian males, who have been the traditional and disproportionate source of America's engineering and science talent, continue to dwindle as a percentage of the workforce. Despite decades of strategies to increase its diversity, the U.S. science and engineering workforce remains about 75% male and 80% White (BEST, 2004). Women, African Americans, Hispanics, Native Americans and persons with disabilities are referred to as the "underrepresented majority." They make up *67%* of the entire U.S. workforce but *account for only 25% of the technical workforce* (Jackson, 2002).

The Nation's greatest untapped resource is America's underrepresented majority. As global competitiveness and the security of future economic mandates challenge the

United States to meet even greater STEM demands, inequities in the education of minority students must become a priority for America. If more URM were educated and trained for science or engineering at the same rate that they have opted for non-STEM majors, this could greatly contribute to the nation's talent pool (Jackson, 2002). America's Talent Imperative is to insure it draws upon the strengths of all groups in science, engineering and technology. Innovation happens fast once all the pieces are in place.

It is imperative that the United States responds to the need for its STEM talent. America must strategically address what has become known as the quiet crisis. The aging of U.S. baby boomers in the current science and engineering workforce must be more than a silent cry. U.S. dependence on international talent is increasing, "even as the nation's firms locate growing numbers of state-of-the-art facilities in countries like China and India that have improved massively in science and engineering education" (Jackson, 2002, p. 4). These trading partners, as they are referred to in the research, recognize that "human capital is their greatest strategic asset, and they are only beginning to leverage it" (Jackson, 2002, p. 5). It is important to identify specific factors that enhance the targeted human capital in this study, which are URM students in STEM disciplines.

Factors that Contribute to Persistence and Retention of URM in STEM

As the economic and educational research has shown, the United States heavily depends on advancements in STEM to maintain its position as the world superpower (Machi et al., 2009). "Science, technology, engineering, and mathematics (STEM) are vital to American competitiveness, yet relatively few students obtain a STEM bachelor's degree" (Business-Higher Education Forum, 2010, p. 3). Golshani (2009), Dean of the

College of Engineering at California State University, Long Beach, further emphasized that shortages in STEM graduates could generate national and international consequences. As the demand for STEM related occupations drastically increases, the nation has a great opportunity to harvest its untapped potential rooted in the recruitment and preparation of URM in STEM in order to reduce some of the major leaks in the STEM pipeline and add more diverse perspectives and innovation to its STEM workforce.

Diversity is important to increase the student talent pool in STEM as well to provide a vitality of viewpoints and solutions in these fields (Davis-Butts, 2006). Furthermore, Davis-Butts (2006) emphasizes that without such inclusion, shortages in STEM disciplines will compromise the future for members of these groups and jeopardize the prosperity of this nation in the global economy. In strategically addressing the need to sustain U.S. productivity and economic strength, URM provide an untapped reservoir of talent that could be used to fill technical jobs (American Association for the Advancement of Science, 2001). Over the past 25 years, educational diversity programs have encouraged and supported URM pursuing STEM degrees. However, minority representation in STEM still lags far behind that of Caucasian males (George et al., 2001). Huang, Taddese, and Walter (2000) authored an NCES study, which emphasized that 46% of White and Asian American college students completed their STEM degree programs within five years of initial enrollment as compared to 27% of their URM peers (Higher Education Research Institute at UCLA, 2010).

To better understand why there is such an underrepresentation of minorities in STEM, the American Association for the Advancement of Science (AAAS) convened a study group meeting in September 2000 of 70 leading educators and researchers in the STEM fields (Olson & Fagen, 2007). They examined over 150 research efforts related to choice of college majors, retention in STEM college majors, academic mentoring at both the pre-college and higher education levels, and pursuit of a STEM doctorate, as well as faculty positions. The group discussed key research, identified gaps, and developed a research agenda for the future. The following three research priorities for URM in STEM from the high school years to the professoriate were identified as: (a) improve methodology, (b) improve research linkages, and (c) explore new research areas.

As it relates to improved methodology, the American Association for the Advancement of Science (AAAS) contends that many studies conducted on URM in STEM have been often too one-dimensional and have taken into account the interactions of one group or only a few stakeholders such as students or faculty. AAAS recommends that studies be more comprehensive and cover more of a variety of key stakeholders. Additionally, they advocate that student cohorts be followed from post-secondary education through faculty positions.

AAAS also proposes improved research linkages. The Association emphasizes that comparable research must be conducted, which offers similar definitions of terms, practice, and data collection process. It suggests that data collection guidelines be developed and common research methods are established, which allow for cross comparison of findings. AAAS recommends that databases are built and maintained to provide education accomplishments and workforce experiences of URM in STEM fields.

Additionally, the group articulated that there is a need to *explore new research areas*. AAAS asserts that there are factors that cause limitations on STEM education research, maintain a low intensity of STEM curriculum at the undergraduate level (both in community colleges and universities), and contribute to a lack of undergraduate faculty mentoring in STEM.

The aforementioned three research priorities contribute to the body of literature specifically as it relates to URM in STEM. In addition, there is a great deal of research that focuses on student factors (persistence) and institutional factors (retention) that contribute to college success. Both are synthesized below.

Individual Student Factors (Persistence and Retention)

Underrepresented minority students have a higher STEM attrition rates in PSE than Caucasian and Asian students. According to White (2005), when the higher attrition and lower graduation rates of URM are scrutinized, upwards of 60% changed majors or dropped out of STEM. The St. John (1989) study identified several factors that contribute to this demise. For example, students who had no parent to graduate from college and worked more than 15 hours per week had lower success levels as compared to students who had at least one college educated parent and worked less than 15 hours a week while in college. This report was based on longitudinal data for 12,000 undergraduate students and highlights other information pertaining to minority students' persistence in the STEM fields. The National Science Board (2010) asserts, "Regrettably, far too many of our most able students are neither discovered nor developed, particularly those who have not had adequate access to educational resources…nor been inspired to pursue STEM, or who have not faced numerous barriers to achievement" (pp. 5-6).

This section provides an overview of the factors that affect persistence for undergraduate college students. Included are student factors (i.e., ACT composite score, participation in academically rigorous curriculum, college GPA, social integration, and percent of hours completed) which enhance students' success.

ACT standardized test scores. The topic of standardized test scores and student persistence has been studied and argued by educators and policy makers for a number of decades. The results of studying student persistence have led researchers to focus on particular variables through the use of models which help predict student persistence (American College Testing, 2008). Although there are many variables or factors proven to enhance student retention, one of the factors used in highly prestigious models is standardized test scores often used as college entrance tests (American College Testing, 2008). Westernburg (2006) contends these models and many studies have consistently shown a strong positive correlation between increasing ACT scores and improved student persistence.

One of the pioneer researchers in this field of student retention and persistence is Vincent Tinto. He along with other researchers support the supposition that a combination of ACT Composite score and high school GPA provides a more accurate basis for making admission decisions to colleges and universities for most groups of students rather than using either measure alone. As it relates to undergraduate STEM majors specifically, GPA and mathematics SAT and ACT scores in particular have been found to positively influence persistence (Bonous-Hammarth, 2000; Sondgeroth & Stough, 1992).

In contrast to the support of strong correlations between ACT composite scores and persistence reported by various educational researchers and agencies, Atkinson and Geiser (2009) contend the following:

> Many deserving low-income and minority students are squeezed out in this competition, and questions about fairness and equity are raised with increasing urgency. The role of the testing agencies themselves has also come into question, and some ask whether the testing industry holds too much sway over the colleges and universities it purports to serve. Underlying all of these questions is a deeper concern that the current regime of admissions testing may impede rather than advance our educational purposes. (p. 665)

The National Science Board (2010) recommends that admission decisions go beyond the use of high standardized test scores and GPA alone and suggests that, "In the STEM areas, all students, including the most talented, should have the opportunity to experience inquiry-based learning, peer collaboration, open-ended, real-world problem solving, hands on training, and interactions with practicing scientists, engineers and other experts" (p. 16).

Academically rigorous curriculum. As it relates to persistence for URM, the role of the high school curricula is highlighted across educational literature. Academic rigor in high school programs has proven to be positively associated with student persistence. The American Council on Education's (2006) article entitled, "Increasing the Success of Minority Students in Science and Technology," identified academic preparation and academic rigor as key factors which enhanced the likelihood of students completing STEM degrees. According to Choy (2002), "taking challenging mathematics courses can mitigate the effect of parents' education on college enrollment" (p. 2). Ploeger (2008) contends that students who are required to enroll in remedial courses often times have had poor quality preparation in high school, which has been linked to low persistence in higher education. URM who lack the academic rigor, which should be obtained in high school, and enter PSE often face unique challenges as they pursue a college degree. According to Carter (2006), the St. John's study revealed that the grades received in high school did not have a substantial influence on the persistence of white students and had no significant relationship to the persistence of African American or Hispanic students. This finding suggests that a main academic effort for increasing persistence for students of color may be in the area of increasing the availability of advanced courses.

Coupled with the lack of academic preparation, URM students also face other challenges including: (a) the dilemma of work-life balance, (b) the pressure of trying to fulfill unrealistic expectations such as school and family obligations and time commitments, and (c) a lack of educational and financial support. Padilla refers to these types of factors as "barriers" that may further hinder URM success if not successfully navigated (Hsiao, 1992). With the rising cost of tuition and major changes in the economic forecast of America, financial support is more important than ever especially as it relates to URM students. One of the major opportunities for students in Louisiana at the regional university is the Tuition Opportunity Program for Students (TOPS). This program is a comprehensive program of state scholarships and one of the most innovative student assistance programs in the nation. Each of its components has specific eligibility and selection criteria, including high school grade point average, ACT score, graduating rank, and completion of a specified college preparatory core curriculum, which is based on academic rigor.

College grade point average (GPA). America is at the risk of having its rising generation less educated than its former generation. According to Thomas (2010), this status quo is especially frightening considering "The graduation rate among 25- to 34-year-olds is no better than the rate for the 55- to 64-year-olds who were going to college more than 30 years ago" (p. 1).

An essential feature of persistence to graduation is maintaining the grade point average necessary to meet graduation requirements. To this end, colleges and universities have established programs that enhance students' academic success. These include summer bridge programs, study skills seminars, and tutoring. According to Persaud and Freeman (2005) participants who have attended first-year seminars and tutoring usually receive higher math course grades as compared to students who do not. Persaud and Freeman further assert;

> Academic and student support services need to be front-end loaded especially for first year students, since the research demonstrates a high attrition rate during the first year of college. In order for students to be retained, they need to develop their skill competencies and confidence in their ability to perform well academically. (p. 2)

Brown, Hershock, Finelli, and Neal (2009) explain, "Students should be encouraged to view their performance as a measure of their effort, not their innate ability in STEM" (p. 5). Students' attitudes about the relationship between grades and ability are closely connected to the concept of self-efficacy. According to Budny and Paul, (2003), studies that highlight the groundwork for degree attainment, especially in the discipline of engineering, can be linked to a student's first semester academic success.

Social integration. While academic performance is important to student success, equally significant is social integration. Psychological theories suggest that involving a student in a small community early in his or her academic career will improve the student's performance and increase the likelihood of retention for that student through developing confidence and facilitating social integration (Bean & Eaton 2001, 2002; Pascarella & Terenzini 1991).

As Tinto (1987) posits,

> Persistence requires that individuals make the transition to college and become incorporated into the ongoing social and intellectual life of the college. A sizable proportion of very early institutional departures mirror the inability of new students to make the adjustment to the new world of the college. Beyond the transition to college, persistence entails the incorporation, which is integration of the individual as a competent member in the social and intellectual communities of the college. (p. 126)

Self-efficacy. Self-efficacy researchers posit that students' confidence in their ability to be successful in science related courses and activities could be referred to as their science self-efficacy (McClure & Rodriguez, 2007). Academic research among STEM undergraduates has associated positive self-efficacy with increased persistence and retention (Lent, Brown, Schmidt, Brenner, Lyons, & Treisman (2003). According to Bandura (1994), Britner and Pajares (2006), and Zeldin and Pajares (2000), self-efficacy influences their choices of science-related activities, the time on task and effort they disburse on those activities, the resiliency they demonstrate when faced with adversities, and the ultimate success they experience in science in particular. According to McClure and Rodriguez (2007), "this makes self-efficacy a prime focus of science educators who want to increase student accomplishment and engagement in science"

(p. 18). Lent, Brown, and Larkin (1984) conducted a study to examine the relationship of self-efficacy beliefs as it relates to students' persistence and success in pursuing science and engineering degrees. Several measures of self-efficacy, such as perceived ability to complete academic rigor and ability to perform STEM job duties were used. Students with higher self-efficacy achieved higher grades and persisted when compared to those with lower self-efficacy in technical or scientific majors over the period of a year.

Continuing research on persistence of underrepresented students is necessary, particularly in the STEM fields, because through the process of "uncovering differences in persistence patterns across diverse groups, we can illuminate factors that inhibit equal opportunity as well as policy factors that might be able to improve opportunity" (Carter, 2006, p. 34). Persistence also remains perhaps one of the most important topics to be studied within the issue of underrepresentation in the STEM fields. Elloitt, Strenta, Adair, Matier, & Scott (1996) contend that once students leave a STEM discipline such as science or premed to major in education or history, it usually means that such students will not return to major in any STEM discipline. Astin (1985), Kuh (2004), Pascarella and Terenzini (1991, 2005) and Tinto (1993) wrote extensively about the important role the institution plays in student persistence. As Tinto (1993) pointed out, the institution must recruit to retain and graduate students. This process involves being aware of the prospective student's expectations of college and his or her academic goals. Persistence is optimized when congruence between the student's expectations and goals matches with the institution's mission and ability (Tinto, 1993). Kuh (2004) further elaborated on the important role of the institution as a provider of the necessary resources, programs, and services deemed necessary to create an atmosphere conducive to student development and success. Retention is another factor shown in the literature that contributes to student success.

Institutional Factors (Persistence and Retention)

It is possible to improve retention rates by attending only to the selection process or only to the learning environment. However, educational research has shown that the greatest gains in retention result from addressing both the selection process and learning environment at once while connecting the two processes together (Thayer, 2000). Retention efforts contain a large repertoire of successful programs including advising, counseling, tutoring, basic skills development, first year orientation (Boudreau & Kromrey, 1994) as well as faculty involvement, study skills courses, test-taking clinics, and career advising. Studies of student retention in higher education have witnessed a marked increase over the last two decades and have revealed the effectiveness of these retention efforts. "Involvement of faculty and staff members in institutional activities also has potentially important implications for the effectiveness of the institution's educational program" (Astin, 1985, p. 144). Educational research has shown that two forms of faculty non-involvement that take away from program effectiveness are part-time status and excessive engagement in outside consulting. Assessment of institutional effectiveness is a necessary and important component to higher education (Kemper & Taylor, 2000; Metz, 2002).

Kuh and Whitt (1988) propose that the culture of a college or university defines, identifies, and legitimates authority in educational settings. However, they caution that institutions may have, perhaps even unwittingly "properties deeply embedded in their cultures that make it difficult for minority students to excel socially and environmentally"

(p. 15). In these instances, students already potentially at risk often find themselves decidedly at odds with popular social and cultural norms on campus (Rendon, Jalomo, & Nora, 2000, p. 7). Students' connection to environment, often called student engagement, and student involvement in campus activities are important factors in retention and persistence (Carter, 2006). Four of the institutional factors identified across the literature, which contribute to student retention, include the following: financial assistance, faculty involvement, campus climate, and institutional commitment.

Financial assistance. According to President Barack Obama (2007), "As tuition costs swell and grant-aid fails to keep pace, students and their families are having a harder time paying for college (p. 1)." This is especially relevant since under-represented minorities tend to have lower incomes than their white counterparts, making college tuition a difficult hurdle (Astin, 1982, 1990). Because of the lack of financial support many URM work off-campus, which research has shown to be negatively associated with college persistence (Callan, 1994). Additionally, URM of lower socioeconomic status tend to be constrained by their financial circumstances in that they attend less expensive institutions closer to their homes (Carter, 1999). According to Garrison (1987), URM enrolled in STEM disciplines and employed beyond campus work study face additional challenges as it relates to academic persistence and time management.

According to Thayer (2000), Thomas Mortenson examined the relationship between family income and educational attainment. This research was conducted over a period of several decades and concluded that students from families in the lower income quartiles are far less likely than those from the upper income quartile to earn a bachelors degree by the age of 24. Mortenson's (1996) research reported that students at the top of the quartile had a 74% success rate in acquiring a bachelor's degree as compared to those at the bottom of the family income quartile, who had a 5% success rate at acquiring a bachelor's degree.

The nature of financial aid received also imparts student persistence. Financial support, in the form of student loans, is often a deterrent for many minority students who are hesitant to incur large amounts of debts in order to obtain a college degree (Stewart, Russell, & Wright, 1997; Thomason & Thurber, 1999). Financial aid, especially in the form of grants, has been shown to foster student persistence (Carter, 2006). According to Landis (1985), The National Action Council for Minorities in Engineering (2008) contends, "availability of adequate financial resources is among the top six factors related to minority persistence in engineering" (p. 33).

Faculty involvement. Academic performance is linked to student/faculty interaction, "supportive" campus environment, and "quality" of institutional relationships with students. Carini, Kuh, and Klein, (2006) posits that the effect is strongest for students with low SATs. They articulated that strong faculty and student interaction in a "supportive" campus environment has been shown to be associated with improved student academic performance (Carini et al., 2006). This could enhance student persistence as well as retention. The Center on Education and Work (2008) recognizes key steps that faculty and staff can take to increase retention of URM in STEM as a result of its meta-analysis studies representing over 19,000 individuals. Some of the key steps identified in the study included: (a) strengthening and encouraging students' confidence as it relates to their ability to successfully navigate higher education, (b) providing prompt attention to changes in students' academic self-efficacy, (c) dealing with students' beliefs about their academic and career expectations, (d) listening to students' bicultural competence and coping skills, (e) addressing students' perceptions of a hostile campus climate at student and staff levels, and (f) exploring factors that enhance students' commitment to the rigor of STEM disciplines and to themselves.

Campus climate. Climate refers to the experience of individuals and groups on a campus. This includes extent and quality of the interaction between those various groups and individuals such as students, faculty and staff. Student learning, recruitment and retention, diversity and inclusion goals can be directly affected. According to the Study Group on University Diversity (2007), "Campus climate is a measure, real or perceived, of campus environment as it relates to interpersonal, academic, and professional interactions" (p. 1). Educators most often assume that schools work and students, parents and the community need to change to conform to this already effective and equitable system (Yosso, 2005). Campus climate should not be measured in a one-size fits all approach. It is fluid and unique from one campus environment to another. According to Cabrera, Colbeck, and Terenzini (2001), URM students, despite having passing grades often did not remain in STEM classes because of a chilly climate. Carter (2006) contends that an inclusive class climate or college environment, which intentionally and purposefully embraces its students as an accepted and welcomed part of the college community, has been linked to persistence; Hurtado, Milem, Clayton-Pederson, and Allen (1998) suggest that when it comes to inclusion, campus climate has been shown to affect retention.

Empirical evidence consistently shows that college students' persistence is partially influenced by both social and social psychological factors (Strayhorn, 2009). As it relates to STEM, campus climate is one of several of these factors which affects students' persistence. Cabrera, Colbeck, and Terenzini (2001) contend that the reason some African, Latino/a, Asian, and Native American (ALANA) students, in particular, did not persist in sciences was because of a chilly climate in their classroom experiences.

Institutional commitment/support. It is important that university leadership demonstrate a strong institutional commitment to increasing URM participation in STEM. Institutions with projects that advance the goal of broadening participation in STEM implement innovative practices when it comes to meeting the needs of URM in STEM disciplines. Hurtado, Cabrera, Arellano, and Espinosa (2008) assert that as a result of "doing science" in several programs, students experienced the collaborative and empowering culture of science. Such experiences foster opportunities for a collaborative and empowering science culture, exhibit strong science identities, and allow for increased self-efficacy. The results for students are more refined and directed career goals.

In the Web-exclusive Q & A, *The Creative Class Struggle*, Hanft (2005) quotes Richard Florida, who posits the following:

> The university is perhaps the single most important institution of the creative age. It's certainly what gave the U.S. its huge edge in the 20th century, by virtue of attracting the best and the brightest from all around the world. Unfortunately, it's also the most mismanaged institution in many cases…The single biggest problem with all universities these days is their apparent inability-and in some cases blatant disinterest-in educating our population broadly across all social, economic, and ethnic demographics. (para. 7)

According to the National Science Board (2010), "Underrepresented minorities are disproportionately absent from the current STEM workforce but comprise the fastest growing college-aged population in the United States" (p. 9). Florida's perspective as it relates to the role of universities suggest that commitment must be to educate students and this is inclusive of all students despite any differences they may have in regards to not being of the majority class or culture.

Conclusion

This chapter provided a synthesis and critique of the theoretical and empirical literature on the factors that contribute to persistence and retention of URM students enrolled in undergraduate STEM disciplines. This review of literature examined a summary of relevant literature in relation to URM students' persistence and retention in STEM fields. The theoretical models on persistence and retention, which included Tinto's Interactionist Model of College Student Departure (1975, 1993), Astin's Input-Environment-Outcome Model of Involvement (1993), and Padilla's Local Expertise Model of Minority Student Success (1991, 1996), have been synthesized and reviewed. Additionally, an examination of the major factors that contribute to the persistence (student factors) and retention (institutional factors) of URM in undergraduate STEM disciplines has been provided. Chapter III introduces the research objectives, design, as well as the methods and procedures proposed to conduct a mixed methods study.

CHAPTER III

RESEARCH DESIGN AND METHODOLOGY

Introduction

In the past 50 years, scientific innovation has fueled approximately half of all U.S. economic growth (National Science Foundation, 2004). According to the United States Bureau of Labor Statistics (2007), jobs in the areas of science, technology, engineering, and math (STEM) are projected to increase by 47% by 2010, which equates to a level of growth three times faster than employment in other fields. As the demand for a STEM workforce continues to rapidly increase, the United States Department of Labor (2007) asserts that America's dominance in STEM fields will not remain secure or advance without concerted efforts and investments from its public, private, and non-profit entities to educate and train an adequate supply of STEM qualified workers.

Education and training are essential to future workers, especially those underrepresented in the STEM workforce (Gilmore, 1999). While the U.S. faces many challenges in meeting STEM workforce demands, preparing under-represented minority (URM) students is a potential solution to the national need as minority enrollment in colleges increase (George et al., 2001). To effectively examine how to increase the rate of URM students' success in STEM fields, more research needs to be conducted on the factors that contribute to minority persistence and retention in private and public institutions of higher education, specifically in STEM disciplines (Tietjen-Smith, Masters, & Smith 2009). Chapter III introduces the research objectives, design, methods and procedures proposed to conduct a mixed methods study.

Research Objectives

The purpose of the study is to identify factors contributing to the perceived persistence and retention of URM students in STEM disciplines at a regional university. Research and pertinent data obtained in this study will offer faculty, administrators, and students at this regional university an opportunity to be better equipped to understand specific factors that lead to greater success for URM students in STEM disciplines. Thus, the researcher will examine the following research objectives:

O_1: Determine the extent to which each of the following factors impact URM student persistence in STEM disciplines at a regional university: (a) ACT composite, (b) participation in an academically rigorous curriculum, (c) financial aid, (d) college GPA, (e) social integration, and (f) percent of hours completed.

O_2: Determine the extent to which each of the following factors impact URM student retention in STEM disciplines at a regional university: (a) ACT composite, (b) participation in an academically rigorous curriculum, (c) financial aid, (d) cumulative GPA, (e) social integration, (f) percent of hours completed, and (g) percent of hours passed.

O_3: Identify factors that influence the perceived persistence of URM students in STEM disciplines at a regional university.

O_4: Determine the extent to which student support services impact the perceived retention of URM students in STEM disciplines at a regional university.

Population

The population in this study is underrepresented minority students (African American, Hispanic, and Native American) both active and inactive, enrolled in STEM disciplines at a regional university during all or part of the Fall 2007-Spring 2010 time frame, with classifications of second semester freshmen, sophomores, juniors, and seniors. The selected university's Office of Admissions reports that out of 10,000 URM students, an estimated 1800 were enrolled for at least one semester in STEM disciplines from the Fall 2007-Spring 2010 time period.

Sampling

Underrepresented minority students enrolled in STEM disciplines during the Fall 2007-Spring 2010 time frame is the population for this study. No sampling was used to address objectives one and two, because the researcher was use the archival data of the entire URM STEM population. However, stratified random sampling was conducted to address objectives three and four in this study.

Stratified random sampling was used to identify URM students based on double strata, which are race or ethnicity and college classification. Patton (1990) asserts, "The logic of purposive sampling [stratified sampling in this study] lies in selecting information-rich cases for the study of depth" (p. 169). Purposeful sampling (stratified sampling) of participants is used to gain multiple perspectives and a deeper understanding of URM students from all three minority groups and from their various student classifications. URM students was randomly drawn based on their ethnicity and then based on their college classification.

The stratified sample drawn will ideally yield a minimum of ten African American, five Hispanic, and three Native American students. Further, stratified sample will ideally yield a minimum of three second semester freshmen, three sophomores, three juniors, and three seniors. The groups in the sample consisted of STEM students of both genders. Kemper, Stringfield, and Teddlie (2003) assert that it is important to use information-rich cases with "an underlying focus on intentionally selecting specific cases that will provide the most information for the questions [for the purpose of this study, research objectives] under study" (p. 279). Various ethnicities and classifications are used to gain the best information in addressing the research objectives. Students from the sample will be offered the opportunity to participate in the study via written letter or email by the researcher after the quantitative phase has been completed. The selection process will continue until a minimum of 18 URM students consent to take part in this study during the Fall 2010 or early Spring 2011 semester.

Research Design

The specific type of mixed method approach used in this study is defined as sequential explanatory design. The research design for this study is a mixed methods approach, which integrates both quantitative and qualitative analysis. According to Patton (2002), quantitative and qualitative research methodologies are effective in addressing research objectives. For the first objective of this study, quantitative analysis is used to determine the extent to which six identified factors impact the persistence of URM students enrolled in STEM disciplines. For the second objective of this study, quantitative analysis is used to determine the extent seven distinct factors impact the retention of

URM students enrolled in STEM disciplines. The nominal group technique (NGT), a qualitative methodology, is used for objectives three and four.

Procedures for Conducting Research

In each phase of this study, ethical issues have been considered. The researcher obtained approval from The University of Southern Mississippi's Institutional Review Board to conduct this research. Required forms were filed, providing information about the principal investigator, type of review, number of subjects, title of the project and type. All sections of the application were completed relating to the project description, procedures, methods, and participants. The following steps in the data collection process were approved to maintain integrity of the research process.

1. Participation was requested from the selected university's Office of Research and the Office of Financial Aid to participate in the study to provide archival, academic, and financial aid data on URM in STEM disciplines from its ISIS and SAM databases for the (2007-2010) time frame.
2. Archival data was entered into SPSS version 16.0 using numbers rather than names to code student data.
3. The use of nominal group technique was used to encourage and maximize participation by all URM students selected as part of the stratified sample in Phase II.
4. Individual sessions were used as appropriate to collect qualitative data based on personal experience via nominal group technique.

5. Data was read and reread several times to improve understanding and analysis.
6. Interpretations of nominal group findings were discussed with URM student participants for accuracy and member checking.
7. Results of the ranking of responses were presented in a rich, descriptive narrative.
8. Finally, analysis of both quantitative and qualitative data sets were analyzed and discussed to answer objectives of the study.
9. Institutional databases used for the study are accessible by authorized faculty and staff only. Written permission was obtained to access database information for this study. All personnel granted accessibility sign a statement of confidentiality relative to student rights and protection. A system of checks and balances for the institutional databases are in place. Student confidentially is given the highest regard, and random audits are conducted by a federal agency that monitors and verifies the accuracy of student records stored in the SAM database. The ISIS database is reviewed on a semester basis with reports to both the regional and state institutions governing boards. ISIS access is granted through approval by: (a) the Office of Undergraduate Admissions, (b) the Office of the Registrar, and (c) the Office of Institutional Research.
10. Anonymity of URM students was protected by coding and securing student responses through password protection and locked file cabinets. Interviewees were given fictitious names to conceal their identity in both

reporting and results. All data retrieved from the participants including interview tapes and archival data retrieved from ISIS and SAM were secured under lock and key in a fireproof file cabinet in the researcher's office.

Sequential Explanatory Mixed Method Design

"Mixed methods research studies use qualitative and quantitative data collection and analysis techniques in either parallel or sequential phases" (Tashakkori & Teddlie, 2003, p. 11). According to Creswell, Plano Clark, Gutmann, and Hanson (2003), "the sequential explanatory mixed methods design is the most straightforward of the six major mixed designs" (p. 223). As a method design, sequential explanatory research requires quantitative data to be collected and analyzed, followed by the qualitative data collection and analysis. Once quantitative and qualitative data are collected and analyzed, the researcher interprets the complete analysis. A sequential explanatory mixed methods design in two distinct phases of data collection and analysis will be employed. The researcher chose the sequential explanatory design because it best addresses the objectives of this study.

In Phase I, the researcher examined archival data that contains descriptive information about URM students enrolled in STEM during the Fall 2007-Spring 2010 time frame. The data is stored in the university's Integrated Student Information System (ISIS) and Student Aid Management (SAM) databases. The extent to which (a) ACT composite, (b) participation in academically rigorous curriculum, (c) financial aid, (d) college GPA, (e) social integration, and (f) percent of hours completed impact persistence and the extent to which (a) ACT composite, (b) participation in academically rigorous curriculum, (c) financial aid, (d) cumulative GPA, (e) social integration, (f) percent of hours completed and (g) percent of hours passed impact retention are examined.

Relationships among factors obtained in Phase I allowed the researcher to determine questions to be used for Phase II of this research. According to Creswell et al. (2003), “the initial quantitative phase of the study may be used to characterize individuals along certain traits of interest related to the research questions [in this study, research objectives]” (p. 227). The researcher examined archival data to determine the impact of factors supported in the literature that contribute to URM student success and student retention. Results from Phase I served as a guide for Phase II. The mixed method design of this study captured the complexity of factors that contribute to URM student success in STEM disciplines.

Phase I - Quantitative

The first objective seeks to determine the extent of impact on persistence of URM students enrolled in STEM by the six factors identified in the literature as impinging on URM students’ success. The second objective seeks to determine the extent of impact on retention of URM students enrolled in STEM by the seven factors identified in the literature as impinging on URM students’ success. Table 1 provides a summary of Phase I data collection and analysis for each of the six factors for persistence and the seven factors for retention.

Table 1

Summary of the Quantitative Phase I of This Research and Research Design Components

Research Objective	Population	Data Collected	Data Analysis
O_1	URM students enrolled in STEM Fall 2007-Spring 2010	Archival Data, which is Demographic Information: Stored in the university databases called, Integrated Student Information Systems (ISIS [10]) & Student Aid Management (SAM [3]) for a total of fifteen factors. Six major factors (i.e., ACT, academic rigor, financial aid, college GPA, social integration).	Logistic Regression will be used to determine the impact of ACT, academic rigor, financial aid, college GPA, social integration, percent of hours completed and persistence of URM enrolled in STEM disciplines. Statistical Package for the Social Sciences (SPSS) 16.0
O_2	URM students enrolled in STEM Fall 2007-Spring 2010	Archival Data, which is Demographic Information: Stored in the university data bases called, Integrated Student Information Systems (ISIS [10]) & Student Aid Management (SAM [3]) for a total of sixteen factors. Seven major factors (i.e., ACT, academic rigor, financial aid, cumulative GPA, social integration, percentage completed and percentage passed).	Logistic Regression will be used to determine the impact of ACT, academic rigor, financial aid, cumulative GPA, social integration percentage completed and percentage passed, and retention of URM enrolled in STEM disciplines. Statistical Packages for the Social Sciences (SPSS) 16.0

Phase II - Qualitative

Qualitative methods are used to address objectives three and four:

O_3: Identify factors that influence the perceived persistence of URM students in STEM disciplines at a regional university.

O_4: Identify student support services that impact the perceived retention of URM students in STEM disciplines at a regional university.

A qualitative approach allows the researcher to further investigate the relationships of URM students' persistence and retention factors based on the quantitative results. This analysis resulted in more than aggregating data from individuals alone; instead, the researcher utilized a nominal group technique to gain the participant's perspective of factors and student support services that impact URM student persistence and retention.

Sampling for nominal group technique was based on students' academic classification (i.e., second semester freshmen, sophomore, junior, senior, or a recent graduate). By selecting different classifications of students, multiple perspectives are gained from the URM participants majoring in STEM disciplines. Creswell (1998) refers to this as the process of maximum variation, defined "as a strategy to represent diverse cases to fully display multiple perspectives about the cases" (p. 120). Multiple perspectives allow the researcher to document perceptions of persistence from different classifications and genders of students for a more accurate account or better representation of all URM students in the target population. Maximum variations in categories of participants allow for richness and depth of perceptions about a topic, which yields multiple perspectives of the phenomena based on the participants' voice. Informant or group perspectives are an important characteristic of qualitative research (Creswell, 1998).

Qualitative research primarily focuses on "the meaning rather than the measurement of organizational phenomena" (Daft, 1983). According to Patton (1991), "Qualitative research methods have been deemed more appropriate for investigating the experiences and interpretations of individuals" (p. 392). Nominal group technique (NGT) was used because it “[is] designed to encourage participation by all members within a group by structure which limits interaction” (Gresham, 1986, p. 2). Additionally, this small group process has been proven to maximize participation, which leads to innovation, creativity, and commitment in-group decision-making activities (Gresham, 1986). The increased participation is based on the design of NGT because it allows for the initial answers to be written rather than orally shared by participants. According to Green (1975), the nominal group technique is ideal for a decision-making process, particularly the problem-identification and solution-generating phases. Student input is important in this study and the nominal group technique allowed for a deeper and richer examination of the participants’ perspective of perceived factors contributing to persistence and retention. The nominal group technique allowed the researcher to gain a more comprehensive and thematic analysis of factors contributing to persistence and retention of URM students in STEM disciplines.

Using qualitative methods, researchers primarily make knowledge claims based on constructivist perspectives that are socially and historically constructed with the intent of discovering a theory or theme (Creswell, 2003). Constructivist perspective could include multiple realities, views, and actions. However, Myers, (2000) posits:

> The ultimate aim of qualitative research is to offer a perspective of a situation and provide well-written research reports that reflect the researcher's ability to illustrate or describe the corresponding phenomenon. One of the greatest strengths of the qualitative approach is the richness and depth of explorations and descriptions. (para. 14)

According to Creswell (2007), "In categorical aggregation, the researcher seeks a collection of instances from the data, hoping that issue-relevant meaning will emerge" (p. 163). Frequency of responses or ideas is categorized as they pertain to the relevant literature in addressing the research objectives. The researcher examined emerging themes from interviews in nominal groups, underlying meanings and similarities, and themes that overlap or appear to form clusters. Creswell (2007) asserts that one of the goals of qualitative research is to more accurately depict the participants' perspectives. Table 2 provides a synopsis of the research components and their alignment with research objectives three and four in this study.

Table 2

Summary of the Qualitative Phase II of This Research and Research Design Components

Research Objectives	Sample	Data Collected	Instruments/ Methods Used	Data Obtained	Data Analysis
(O_3 & O_4)	Stratified sample of URM enrolled in STEM at a regional university during the Spring 2007- Fall 2010 time frame	Overall URM responses to opened ended questions and their rankings	Open Ended Questions derived from logistic regressions results in Phase One Nominal group technique (NGT)	Participant interviews, numerical ranking, and group consensus of overall perceived factors that contribute to persistence and retention of URM students in STEM at a regional university	Thematic analysis

The final step of sequential explanatory design is to interpret the results of the analysis. A final discussion based on the results of Phase I and II analysis was conducted and "analyzed by the [nominal] group before evaluation or prioritization takes place"

(LIGO Hanford Local Educators' Network Focus Group, 2003, p. 1) as a form of member-checking depicted in Table 3. According to Creswell (2007):

> [Sequential explanatory design] is easy to implement because the steps fall into clear separate stages. In addition, this design feature makes it easy to describe and report. In fact, this design can be reported in two distinct phases with a final discussion that brings the results together. (p. 227)

Table 3

Process of Interpretation of Entire Analysis

Phase I Quantitative Data Analysis	Phase II Qualitative Data Analysis	Interpretation of Entire Analysis
Extent (6) persistence and (7) retention factors based on review of literature (i.e., ACT, academic rigor, financial aid, college GPA, social integration, percentage hours completed, percentage hours passed) impact URM students' success in STEM disciplines	Discuss and analyze participant responses before the completion of prioritization and thematic analysis	Construct written narrative of combined analysis

Three key steps are considered when using mixed methods. According to Creswell et al. (2003), mixed methods research design steps include priority, implementation, and integration. The first step according to Creswell et al. (2003) is priority. Priority means the researcher determines which method, quantitative or qualitative, receives greater emphasis. In this study, the quantitative and qualitative methodologies will be given equal priority. Priority is not defined by which method comes first in sequence. In sequential explanatory research, priority can be quantitative, qualitative, or equal (Creswell et al., 2003). Since the researcher has selected the sequential explanatory design, the quantitative phase of the research is predetermined to be conducted first.

The second key step to consider in mixed methods research design is implementation. Implementation refers to sequencing of quantitative or qualitative methods. Quantitative analysis of the archival data will occur first, followed by qualitative data analysis using nominal group technique as the methodology. The third key step for mixed methods research design is integration. Integration involves mixing quantitative and qualitative data analysis and interpretation to more effectively address the research objectives.

According to Johnson and Onwuegbuzie (2004), "mixed methods research combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study" (p. 17). Mixed methods is determined to be the most appropriate research design for this study because of the complexity of factors that contribute to URM students' persistence and retention in STEM disciplines as they overcome barriers in the educational pipeline. The choice of a mixed methods research design best supports a broad range of data collection and the triangulation of quantitative to qualitative methods to increase the validity or credibility of the findings and establish a more comprehensive analysis (Tashakkori & Teddlie, 2003). A detailed explanation of validity and credibility is discussed later in this chapter. Patton (2002) points out that a key quality of a mixed methods approach is that it provides for a triangulation of the data collection, which "…strengthens a study by combining methods" (p. 247).

Triangulation

Denzin (1978) identified four types of triangulation: data, investigator, theoretical, and methodological triangulation. This study will be conducted using the fourth of Denzin's types, methodological triangulation – the use of multiple methods to study a single phenomenon. Morse (1991) records Sequential Explanatory Design as one of the classifications of methodological triangulation.

Rossman and Wilson (1985) posit three specific reasons for combining quantitative and qualitative research, which are significant and contribute to triangulation and strengthen internal validity for this study. The combinations of quantitative and qualitative mixed methods are used to: (a) initiate new ideas or interpretations, which emerge from both quantitative and qualitative data sources; (b) provide both richness and detail; (c) allow for validation of both the quantitative and the qualitative data through the process of triangulation; and (d) allow for a more comprehensive analysis of the potential relationships between URM student retention and the seven factors in the literature that contribute to student success. The seven factors are based primarily on the theories of Tinto, Astin, and Padilla.

Data Collection

Tinto, Astin, and Padilla posit that there are specific factors which contribute to student success. A total of seven factors are identified in the literature as major contributors to student retention, an institutional measure of success. They are (a) ACT composite scores, (b) participation in an academically rigorous curriculum, (c) financial aid, (d) GPA, (e) social integration, (f) percent of hours completed, and (g) percent of hours passed.

The researcher obtained archival data via oral and written requests from the institution's Office of Institutional Research and Financial Aid Office for all URM students majoring in STEM disciplines. All factors used are based on the review of the literature. Additional data was collected as described below.

The researcher used the factors of gender, race, ethnicity, and classification for the stratified random sampling for objectives three and four. These factors enabled the researcher to identify and gain multiple perspectives from the various groups represented in the study. Data retrieved from the university database (ISIS) included: (a) gender, (b) race, (c) ethnicity, (d) classification (e) ACT composite score, (f) social integration, defined by campus residency status, work study employment on campus, (g) college GPA, (h) cumulative GPA (i) percent of hours completed, and (j) percent of hours passed.

Additionally, three factors that also contribute to URM student success will be examined. The factors were retrieved from SAM, a university database which includes: (a) academic rigor, (b) financial aid, (c) financial aid identified as Pell eligible and student loan recipients. Data was drawn from both ISIS and SAM for this study. Retention measures were examined by the researcher based on the seven major factors identified in the literature: ACT composite score, academic rigor, financial aid, college GPA, social integration, percent of classes completed, and percent of classes passed.

In Phase II of this study, nominal group technique (NGT) was used to collect data from students in order to gain the "input of many individuals without the dysfunction of unbalanced participation which often occurs in large groups" (Gresham, 1986, p. 12). According to Clark and Stein (2004), "Nominal group meetings allow for individual brainstorming as well as group dynamics to generate rich, qualitative information, which is then prioritized by [placing] participants into easier to analyze and understand quantitative information sessions" (p. 3). Nominal group technique is a structured variation of small group methods that prevents individuals from dominating discussions. NGT encourages participation from every group member including those who are passive, while resulting in a set of prioritized solutions.

According to the World Bank Institute (WBI) Evaluation Group (2007), nominal group technique, like any other methodology, has advantages and disadvantages. The advantages of nominal group technique, as a data collection methodology, are that it allows:

1. More structured approach than a traditional focus group approach.
2. Contributions from all group members, while avoiding the likelihood of individual participant domination or control.
3. Opportunities for participants to prioritize concerns they have as represented group members.
4. Effective use with small or large number of participants.
5. Low financial cost.

World Bank Institute Evaluation Group (2007) posits some of the disadvantages or drawbacks of nominal group technique as follows:

1. Synergism may not evolve as easily in nominal group technique.
2. Nominal group technique may feel less like natural unfolding and more mechanical to participants.

3. Although nominal group technique allows for a range of group sizes, it is hard for a researcher to implement it effectively with large audiences without very careful and strategic planning.

In order to implement nominal group technique in this study, eleven steps were taken as part of the Phase II data collection:

1. Eighteen URM students were selected using a stratified sampling technique. According to Siemer, Connelly, Brown, and Decker, (2001), “The nominal group technique is a meeting with a small group of participants designed to generate and prioritize ideas about a particular topic” (p. 6). The researcher asked all of the URM (18) students in the sample to sit at one of three separate tables (or table areas) located in the institution’s department of student services conference room with a maximum of six URM students seated at each table or area.
2. Open-ended question(s) were posed to the entire group of selected URM students based on the quantitative findings from Phase I of the study. Questions asked related to relationships between URM students’ persistence and ACT composite scores, academically rigorous curriculum, financial aid (gift award) recipients, college GPA, social integration and percent of hours completed. Additionally open-ended questions relating to URM students’ retention and ACT scores, academically rigorous curriculum, financial aid (gift award) recipients, cumulative GPA, social integration, percent of hours completed, and percent of hours passed were posed. Time allotted was 5-7 minutes per question.

3. All of the selected URM students were asked to first spend 15 to 20 minutes in silence, individually brainstorming possible answers or ideas to the question(s) posed by the researcher, and then to write down notes for their responses in a bulleted or abbreviated format.
4. Data was collected as the URM students shared responses (one response at a time per person). Round robin recording of responses or ideas was placed on a flipchart for all participants to view. The researcher asked the URM students not to comment on the answers or ideas, but encouraged serial discussion for clarification of responses written on the flipchart. The researcher removed answers or ideas recorded more than once to avoid duplication. This process took approximately 80 minutes.
5. Flipchart sheets were hung next to each other to be viewed simultaneously. Then, each URM student was asked to evaluate the answers or ideas individually.
6. Once URM students examined all answers or ideas, the researcher a letter (i.e., a, b, c, d, e, f, and g) was assigned by the researcher to each contribution or response written on the flipchart. Responses exceeding the letter “z” were labeled using double letters (i.e., aa, bb, cc…) until each response had at least one letter in front of it.
7. Participants were given five 3 x 5 index cards and asked to identify the five most important responses on a separate index card using the letters and responses on the flipchart.

8. Next, URM students were asked to number the index cards five, four, three two, one, individually ranking the top five responses based on priority, from 1 to 5, with five being the highest priority and one being the lowest priority until all five responses or ideas were ranked. The ranking of ideas took approximately 45 minutes.
9. As participants read through the list of recorded responses, round robin reporting was used to record the number of votes each response or idea received based on the rank given by the URM students.
10. All the ranks for each response were aggregated on the flip chart to identify the values given the top five priorities for URM students participating in the nominal group.
11. Finally, time was allowed for discussion and brief group presentations of their solutions.

Internal and External Validity

Shadish, Cook, and Campbell (2002) refer to the term validity as an approximate truth of inference or conclusion. Research validity, therefore, is considered the validity based on the conclusions of the researcher. Four types of research validity are commonly examined in social sciences research: statistical conclusion validity, internal validity, construct validity, and external validity. In this study, the researcher will address threats to internal and external validity.

Internal validity. According to Shadish et al. (2002), internal validity refers specifically to whether an experimental treatment or condition makes a difference and is the right experimental design for cause and effect. Additionally, Cook and Campbell

(1979) identify several threats to internal validity. They include: (a) single group threats such as history group, maturation, testing, instrument, morality, and regression threat; (b) multiple group threats which include selection-history, selection-maturation, selection-testing, selection-instrumentation, selection-mortality, and selection-regression; and social interaction threats which consist of imitation of diffusion or imitation of treatment, compensatory rivalry, resentful demoralization, and compensatory equalization of treatment. The researcher carefully and systematically examined possible threats which could influence data in this study. Two of the more immediate treats in this study were statistical conclusion, where validity may be based on a decision as to whether or not variables are related to one another. The other threat was construct validity, which examines if a test did or did not measure what was intended.

Selection is another threat to internal validity. Shadish et al. (2002) defines selection as "Systematic differences over conditions in respondent characteristics that could also cause the observed effect" (p. 55). Although the majority of URM students at the regional university enrolled in STEM disciplines are African American, stratified sampling was used to select representation from all three ethnic minority groups, which includes African American, Hispanic, and Native American.

In order to reduce errors in mixed methods research, validity and reliability are necessary. Yin (2003, p. 37) highlights the need for "minimizing the errors and biases in this study," requiring several steps that will ensure reliability. The researcher used the following strategies to promote internal validity in this study: (a) member-checking, (b) identification of bias on the part of the researcher, (c) addressing alternative explanations, and (d) triangulation of the data. Student interviews were shared with interviewees for accuracy and validity in interpretation. In the nominal group technique, round robin reporting was done verbatim, which included requests for clarity to accurately document responses. Along with internal validity, the researcher also considered threats to external validity.

External validity. External validity is the degree to which results can be generalized to groups and environments outside of the research setting. According to Zapf (2010), a clearly defined population is one of the requirements for strong external validity that will allow the researcher to determine whether on not he or she can generalize to others with confidence. Shadish et al. (2002) list threats to external validity as the following interactions: (a) units, (b) treatments, (c) outcomes, and (d) settings.

Identifying the population to which the results of a study can be generalized is significant. The population for this study includes all URM students enrolled in STEM at a regional university during the Fall 2007-Spring 2010 time fame. Using a stratified random sample, representation from each of the URM (African American, Hispanic, and Native American) student groups supported stronger external validity for the study. Various classifications were used to include at least one second semester freshmen, a sophomore, a junior, or a senior. The results of this study are generalizable subject to the validity concerned addressed in this chapter.

Summary

In Chapter IV, the results of this study are analyzed and presented. Chapter V recaps the study's design and discussed conclusions and recommendations for future studies.

CHAPTER IV

DATA ANALYSIS

The purpose of this study was to investigate factors that contribute to persistence and retention of minority undergraduate students in science, technology, engineering, and math (STEM) during the Fall 2007 - Spring 2010 time frame at a regional university. The researcher used sequential explanatory design, as depicted in Figure 6, which allowed a comprehensive examination of factors contributing to student persistence and retention. Additionally, the steps of the methodology are listed in the bottom section of Figure 6.

Research Design and Methodology

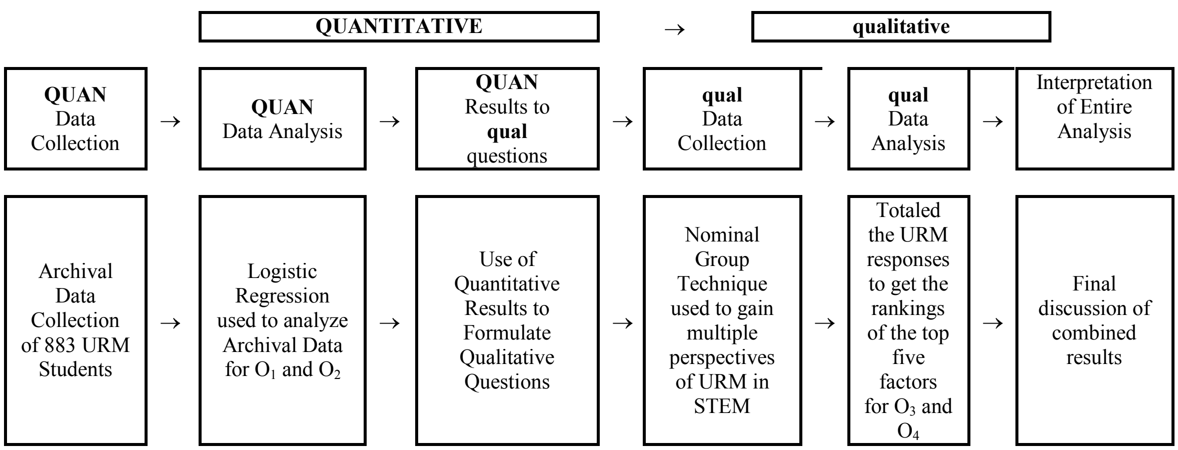

Figure 6. Sequential Explanatory Design. Adapted from Tashakkori and Teddlie (2003, p. 225).

According to Creswell et al. (2003), “The straightforward nature of this [sequential explanatory] design is one of its main strengths” (p. 227). In sequential explanatory design, the researcher performs quantitative data collection and analysis followed by qualitative data collection and analysis (Tashakkori & Teddlie, 2003). Data collection and analysis for the following four research objectives was divided into two distinct sequential phases:

O_1: Determine the extent each of the following factors impact URM student persistence in STEM disciplines at a regional university (a) ACT composite score, (b) participation in an academically rigorous curriculum, (c) financial aid, (d) college GPA, (e) social integration, and (f) percent of hours completed.

O_2: Determine the extent each of the following factors impact URM student retention in STEM disciplines at a regional university (a) ACT composite score, (b) participation in an academically rigorous curriculum, (c) financial aid, (d) cumulative GPA, (e) social integration, (f) percent of hours completed, and (g) percent of hours passed.

O_3: Identify factors that influence the perceived persistence of URM students in STEM disciplines at a regional university.

O_4: Determine the extent to which student support services impact the perceived retention of URM students in STEM disciplines at a regional university.

Factors Analyzed

Descriptive statistics were used to analyze demographic data retrieved from archival data. Results of Phase I analysis addressed research objective one (O_1) and research objective two (O_2). The following factors as shown in Tables 4a and 4b were taken from ISIS and SAM to conduct this study.

Table 4a

Thirteen (13) Total Factors (Variables) in ISIS (10) and SAM (3), Which Represent Archival Data Based on Literary Review and Research Objectives

1. Gender	6. *Undergraduate Cumulative (GPA)
2. Race	7. *ACT (American College Testing) composite score
3. Ethnicity	8. *Percent hours completed
4. Classification	9. *Percent of hours passed
5. *College Grade Point Average (GPA)	10.*Social integration (residential status, work study job)

Table 4b

SAM Factors (Variables)

1. *Academic rigor (TOPS) in database
2. *Financial Aid (Pell eligible, loans, university scholarship)
3. *Financial Aid identified as Pell eligible and student loan recipient

Note * Major factors (variables) that contribute to persistence and retention according to the review of the literature (applicable to Tables 4.1.a and 4.1.b). The remaining factors are necessary to identify students' race, gender, and ethnicity for stratified sampling in nominal group technique.

Planning the study required the researcher to identify factors that are significant based on the review of literature. The list of factors is highlighted in Table 5.

Table 5

Factors in the Literature that Contribute to Persistence and Retention as Identified by Tinto, (1975, 1987, 1993); Astin, (1984, 1985) & Padilla, (1999)

Individual Factors (Student)	Institutional Factors (College/University)
*Academic rigor (measured by TOPS participation)	Faculty Involvement

Table 5 (continued).

Individual Factors (Student)	Institutional Factors (College/University)
*ACT (American College Test)	Institutional Support
*Social Integration (residential status, work study job)	Campus Climate
*College GPA	*Financial Aid (grants, loans, university scholarships)

Phase I Quantitative Analysis (Descriptive Data and Logistic Regression)

In Phase I of this study, quantitative analysis of archival data was used to explore the impact of specific factors on URM student persistence and retention in STEM disciplines. Logistic regression was used as the statistical procedure to address research objectives one and two. In Phase II, qualitative analysis was used to examine URM student perceptions of their persistence to remain in a STEM curriculum, as well as their perceptions of the impact of student support services on their decisions to stay enrolled in STEM disciplines. The Nominal Group Technique (NGT) was used to address research objectives three and four.

The first step in most research is to describe the target population of the study (Mertler & Vannatta, 2005). Archival student data was retrieved from the regional university's Integrated Student Information System (ISIS) and Student Aid Management (SAM) databases. The archival data included URM student demographic information and predictor variables. Descriptive statistics were used to describe the target population of 883 URM (African American, Hispanic, Native American) students at a regional university enrolled in a STEM discipline between the Fall 2007 and Spring 2010 semesters. All of the descriptive statistics were generated using SPSS (16.0).

Descriptive data of the 883 URM students in the target population was separated into two datasets defined as a persistence dataset and a retention dataset. The persistence dataset included selected archival student data of 196 URM students from the Fall 2007 freshmen cohort. The 196 URM students only included first semester college freshmen majoring in STEM fields. The researcher examined six predictor variables or factors (see items a through f below) shown in the literature to contribute to URM student persistence in STEM disciplines. The following six factors addressed research objective one: (a) ACT composite score, (b) participation in an academically rigorous curriculum, (c) financial aid, (d) college GPA, (e) social integration, and (f) percent of hours completed.

The retention dataset was retrieved from archival student data using the remaining 687 URM students (freshmen, sophomores, juniors) who enrolled in a STEM discipline between Fall 2007-Spring 2010 time frames. It should be noted that the freshmen in the retention dataset were not first semester freshmen; therefore, they were *not* included in the freshmen cohort. The dataset included multiple observations for individual students if they were retained over multiple semesters. Thus, there were 1375 observations in the output taken from the retention dataset.

Seven factors (see items a through g below) found in the retention dataset, which have been shown in the literature to contribute to URM student retention were examined. The following seven factors addressed research objective two: (a) ACT composite score, (b) participation in an academically rigorous curriculum, (c) financial aid, (d) cumulative GPA, (e) social integration, (f) percent of hours completed, and (g) percent of hours passed.

Demographic Data

The results from the archival student data as it relates to gender, race/ethnicity, classification, and the specific academic STEM major are depicted in Tables 6, 7, 8, and 9 for both persistence and retention. In Table 6, the percentage of female students enrolled in STEM disciplines in the persistence data was 46.4% and in the retention data was 43.4%. Although the overall university population has more female (57.7%) than males (42.3%) students, fewer URM females enrolled in STEM disciplines in the 2007 through 2010 semesters. A high number of female students enrolled in biology in this study relative to other STEM disciplines.

Table 6

Persistence and Retention: Gender

	Gender	Frequency	Percent
Persistence	Females	91	46.4
	Males	105	53.6
	Total	196	100.0
Retention	Females	298	43.4
	Males	389	56.6
	Total	687	100.0

Of the 91 female URM students in the persistence dataset, two out of three (n = 65) or 71.4% were enrolled in biology during the Fall 2007–Spring 2010 semesters. Additionally, of the 298 female students in the retention dataset, two of three (n = 198) or 66.4% also enrolled in biology. The area of race or ethnicity among URM students in STEM disciplines in both datasets was examined.

As shown in Table 7, the race or ethnicity of the 196 URM students in the persistence dataset consisted of the following distributions: African Americans (n = 167), Hispanics (n = 24), and Native Americans (n = 5). Furthermore, assessment of the race or ethnicity of the 687 URM students in the retention dataset revealed: African Americans (n = 598), Hispanics (n = 71), and Native Americans (n =18). The higher percentage of African American students enrolled in STEM disciplines is consistent with the overall population at this regional university and higher than the percentage of Hispanic and Native American students combined. The next area addressed by the researcher was student classification.

Table 7

Persistence and Retention: Race/Ethnicity

	Race/Ethnicity	Frequency	Percent
Persistence	African American	167	85.2
	Hispanic	24	12.2
	Native American	5	2.6
	Total	196	100.0
Retention	African American	598	87.1
	Hispanic	71	10.3
	Native American	18	2.6
	Total	687	100.0

As seen in Table 8, the Fall 2007 enrollment for URM first semester freshmen was 196 in STEM disciplines. It is important to note that the URM freshmen students in the retention dataset consisted of those who were not in the 2007 freshmen cohort because they were not first semester freshmen. These non-first semester freshmen in the retention dataset represented (n = 500), sophomores (n = 108), and juniors (n = 79) as shown in Table 8.

Table 8

Persistence and Retention: Classification

	Classification	Frequency	Percent
Persistence	Freshmen Cohort	196	100.0
Retention	Freshmen	500	72.8
	Sophomores	108	15.7
	Juniors	79	11.5
	Total	687	100.0

Descriptive statistics revealed that a high number of URM students remained classified as freshmen based on the low number of hours they successfully completed. Moreover, the number of URM students in the STEM pipeline decreased as the classification level increased at this university. For example, Table 6 reveals that while there were (n = 500) freshmen, the number of sophomores decreased to (n = 108), and the number of juniors decreased even more to (n = 79). It is important to note that seniors, who may have been enrolled during the Fall 2010 semester, were not included in this study because it could not be determined if they dropped out or graduated by the Spring 2010 semester. The final descriptive area of persistence and retention examined by the researcher was the URM students' academic STEM majors and the distribution of students within each major.

According to Table 9, the 196 URM students in the persistence dataset majored in one of 16 STEM disciplines. Additionally, the 687 URM students in the retention dataset majored in one of 24 STEM fields. The highest distribution of URM students in the persistence and retention datasets were enrolled in biology, computer science, and industrial technology as shown in Table 9. Biology, computer science, and industrial technology were the three largest majors in both datasets. In the persistence dataset (see Appendix A), descriptive statistics revealed that there were no females enrolled in civil engineering, electrical engineering, or geology. Conversely, there were no males enrolled in physics during the Fall 2007–Spring 2011 semesters.

Table 9

Persistence and Retention: Academic STEM Majors

Academic STEM Major	Persistence		Retention	
	Frequency	Percentage	Frequency	Percentage
Agribusiness, Concentration	1	.5	6	.9
Animal Science, Concentration	3	1.5	16	2.3
Biology	86	43.9	233	33.9
Chemical Engineering	5	2.6	32	4.7
Chemistry	5	2.6	15	2.2
Civil Engineering	5	2.6	17	2.5
Computer Science	30	15.3	87	12.7
Electrical Engineering, Computer Engineering	11	5.6	45	6.6
Electrical Engineering, Telecommunications Engineering	0	0.0	3	.4
Electrical Engineering	11	5.6	33	4.8
Environmental & Sustainable Resources	0	0.0	1	.1
Geology	1	.5	0	0.0
Industrial Technology, Associate	0	0.0	1	.1
Industrial Technology	15	7.7	82	11.9
Landscape & Horticulture Management	0	0.0	1	.1
Mathematics	2	1.0	6	.9
Mechanical Engineering, CAD/CAM	0	0	2	.3
Mechanical Engineering	11	5.6	54	7.9
Microbiology	3	1.5	25	3.6
Natural Resources & Environmental Quality	0	0.0	2	.3
Petroleum Engineering	6	3.1	21	3.1
Physics	1	.5	1	.1
Plant Science, Concentration	0	0.0	1	.1
Resource Conservation & Comm Sustain	0	0.0	1	.1
Resource Biology/Biodiversity	0	0.0	2	.3
Total	196	100.0	687	100.0

A descriptive examination of gender according to academic major for both persistence and retention revealed that 263 or 76.7% of the biology majors were female and 80 or 23.3% were male (see Appendixes A and B). Industrial technology, landscape and horticulture management, mechanical engineering computer-aided design (CAD) and computer-aided manufacturing (CAM), natural resources and environmental quality, and resource biology/biodiversity consisted of only male URM students (see Appendixes A and B). Descriptive examinations for both persistence and retention revealed only female students had academic majors in physics and plant science. The researcher used logistic regression to conduct the remainder of the data analysis.

Logistic Regression

In this study, logistic regression analysis was employed as the statistical methodology to determine the impact of specific factors on persistence and retention of URM students enrolled in STEM disciplines. According to Agresti and Finlay (1997), logistic regression is an appropriate tool for assessing the probability that students with a particular set of variables will be successful as it relates to undergraduate persistence or retention. Logistic regression was applied using the “ENTER” procedure in SPSS (16.0). The overview of the logistic regression models along with the outputs for persistence and retention are presented in the following paragraphs.

Overview of the Logistic Regression Models

White (2005) posits “logistic regression in SPSS applies maximum likelihood estimation after transforming the dependent variable into a logit variable” (p. 1). Two logistic regression analyses were conducted using two dependent variables along with covariates in two separate datasets. The first dependent variable was *persistence* and its six covariates or factors, which included (a) ACT composite score, (b) academically rigorous curriculum, (c) financial aid, (d) GPA, (e) social integration, and (f) percent of classes completed. *Retention* was the second dependent variable along with its seven covariates or factors, which included (a) ACT composite score, (b) academically rigorous curriculum, (c) financial aid, (d) GPA, (e) social integration, (f) percent of classes completed, and (g) percent of classes passed. The percent of classes completed is defined as the number of hours a student earned minus the number of hours actually registered (i.e., registered for 18 hours, but earned 15). The completion of a course may include the letter grade of "F". The percent of classes passed is defined as the number of hours a student attempted in which a passing grade of a "D" or above was earned. First the dependent variable (persistence) was put into the equation and then six aforementioned covariates were simultaneously put into the model in relation to the 196 URM students in STEM.

Persistence Output

Regression results for the persistence data indicated that the overall model fit of 6 predictors was acceptable (-2 Log Likelihood = 134.591) and was not significantly different from what was expected and shown in the Hosmer and Lemeshow χ^2 (8) = 8.411, p = .394 as shown in Table 10 and 11. Based on the classification output, the overall percentage of the total cases correctly classified for URM student persistence in Step 1 was 85.2% in Table 12. Additionally, the proportional reduction in error (PRE) statistic was calculated from analyzing the classification table. In order to calculate the PRE, the number of errors without the model was subtracted from the number of errors with the model, and then the sum was divided by the number of errors without the model

(Menard, 2002). The PRE statistic (in Table 12) reveals 31% fewer classifications errors when using the model to predict persistence compared to not using the model.

Typically, the test of significance for the entire logistic regression model is the Hosmer and Lemeshow χ^2. The Wald statistic, which test individual predictors, reveals that grade point averages (GPA) and percent of courses completed were found to be statistically significant predictors of the likelihood of URM freshmen 2007 cohort persistence. A URM student with a higher grade point average is 3.670 times as likely (or 3.670 - 1= 2.67 × 100 = 267% more likely) to persist [all else being equal] in a STEM discipline. Under-represented minority students are .779 times as likely (or .779 -1 = - 0.221 × 100 = 22.1% less likely to persist [all else being equal] if they drop fewer courses. Table 10 highlights GPA (ß = 1.300, $p < .001$) and percent of courses completed (ß = .249, $p = .006$) as statistically significant predictor variables. In general, the results in Table 10 tell that GPA is a strong indicator of URM students' persistence. Additionally, for every one unit increase in GPA, the odds of a URM student in a STEM discipline persisting increases by a probability of 3.670. The higher the percentage of courses that URM students complete (or the fewer they drop), the more likely they are to persist in STEM disciplines.

Table 10

Persistence: Logistic Regression, Factors (N = 196)

	PERSISTENCE	ß	S.E.	Wald	df	Sig. (≤.05)	Exp(ß)
Step 1	ACT composite	.005	.087	.003	1	.958	1.005
	Academic rigor	-.201	.568	.126	1	.723	.818
	Financial aid	-.256	.543	.222	1	.637	.774

Table 10 (continued).

	PERSISTENCE	ß	S.E.	Wald	df	Sig. (≤.05)	Exp(ß)
Step 1	GPA	1.300	.303	18.408	1	.000	3.670
	Social integration	-.820	.427	3.697	1	.055	.440
	Percent of courses completed	.249	.090	7.627	1	.006	.779
	Constant	-3.359	1.723	3.798	1	.051	.035

Table 11

Persistence: Hosmer and Lemeshow Test of Goodness of Fit

Hosmer and Lemeshow Test			
Step	Chi-square	df	Sig.
1	8.411	8	.394

The Nagelkerke R^2 value (.366) in Table 12 indicated that approximately 37 % of the variance in persistence is explained by the model.

Table 12

Persistence: Logistic Regression, Nagelkerke R Square (N = 196)

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	134.591	.223	.366

Table 13 revealed (13 / 35 = 37.1%) of the URM students in the 2007 freshmen cohort persisted until the Fall 2010 semester. Unfortunately, this classification data suggest that a larger percentage of the freshmen cohort at this university, dropped out, switched majors, or stopped out of STEM disciplines before the Fall 2010 semester. The SPSS output for persistence revealed (154/161 = 95.7%) were correctly classified. Overall the predictions were correct 167/196 times, for an overall success rate of 85.2% as shown in Table 13.

Table 13

Persistence: Logistic Regression, Classification (N = 196)

Classification Table

			Predicted		
			Persist		
	Observed		0	1	Percentage Correct
Step 1	Not Persist	0	154	7	95.7
	Persist	1	22	13	37.1
		Overall Percentage			85.2

a. The cut value is .500

After all of the persistence data had been placed in SPSS (16.0) and examined, logistic regression was conducted with the retention data. Two separate logistic regression analyses were conducted. The first logistic regression analysis was conducted using persistence and the second was conducted with retention.

Retention Output

Retention, as the second dependent variable, was put into the equation and then its seven aforementioned covariates were simultaneously put into the model in relation to the 687 URM students in STEM. Note that there are 687 URM students in this data set; however, the output reveals 1375 cases because of multiple observations related to URM students’ semester to semester retention in STEM disciplines.

The Wald statistic for this model as it relates to individual predictors indicate that academically rigorous curriculum, undergraduate cumulative GPA, percent of classes completed, and percent of classes passed were found to be statistically significant predictors of the likelihood of URM student retention for a least one additional semester. Under-represented minority students who took part in an academically rigorous curriculum were 1.490 times as likely (or 1.490 - 1 = 0.49 × 100 = 49 % more likely) to be retained through the next semester. Under-represented minority students with higher undergraduate cumulative GPAs are more likely to be retained (or 1.657 - 1 = .657 × 100 = 65.7 % more likely) to remain in school. Students who have a higher percentage of classes completed are 11.803 times as likely (or 11.803 - 1 = 10.803 × 100 = 1,080.3 % more likely) to remain in school. Additionally, URM students who have a higher percentage of successfully passed classes are 1.465 times as likely (or 1.465 - 1 = .465 × 100 = 46.5 % more likely) remain in school. In general, URM students who have completed an academically rigorous curriculum (ß = .399, p = .015), a higher undergraduate cumulative GPA (ß= .505, p = .000), a higher percentage of course completion (ß = 2.468, p = .000) and passing grades (ß = .382, p = .010) are more likely to be retained through the next semester of college. Table 14 highlights the results of the remaining variables.

Table 14

Retention: Logistic Regression, Factors (N = 687)

Step	RETENTION	ß	S.E.	Wald	df	Sig.(≤.05)	Exp(ß)
1	ACT Composite	.006	.022	.074	1	.786	1.006

Academically rigorous curriculum	.399	.165	5.869	1	.015	1.490

Table 14 (continued).

Step	RETENTION	ß	S.E.	Wald	df	Sig.(≤.05)	Exp(ß)
1	Financial aid	.006	.083	.005	1	.946	1.006
	Undergraduate cumulative GPA	.505	.129	15.340	1	.000	1.657
	Social integration	-.182	.122	2.220	1	.136	.833
	Percent of Classes Completed	2.468	.340	52.671	1	.000	11.803
	Percent of Classes Passed	.382	.148	6.682	1	.010	1.465
	Constant	-3.208	.615	27.216	1	.000	.040

Regression results for the retention data indicated that the model fit of seven predictors was acceptable (-2 Log Likelihood = 1420.145) and was not significantly different from what was expected and seen in the Hosmer and Lemeshow χ^2 (8) = 8.622, p = .375 as shown in Table 15. Based on the classification output, the overall model correctly classified 73.8% of the total URM student retention cases in Step 1. The PRE statistic (in Table 17) reveals 71.4% fewer classifications errors when using the model to predict persistence compared to not using the model. The PRE statistic was calculated by the following: The number of errors without the model was subtracted from the number of errors with the model, and then the sum was divided by the number of errors without the model (Menard, 2002).

Table 15

Retention: Hosmer and Lemeshow Test of Goodness of Fit

Hosmer and Lemeshow Test			
Step	Chi-square	df	Sig.
1	8.622	8	.375

The Nagelkerke R^2 value (.129) in Table 16 indicates that approximately 13 % of the variance in retention is explained by the model.

Table 16

Retention: Logistic Regression, Nagelkerke R Square (N = 687)

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	1420.145[a]	.090	.129

Table 17 highlights the classification output for the retention data in this study. The actual number of student in the retention dataset equaled 687. Higher numbers shown in Table 17 represent multiple observations of retained URM students.

Table 17

Retention: Logistic Regression, Classification (N = 687)

Classification Table					
			Predicted		
			Retain		
	Observed		0	1	Percentage Correct
Step 1	Not Retained	0	65	299	17.9
	Retained	1	42	895	95.5
		Overall Percentage			73.8

Classification Table

			Predicted		
			Retain		
	Observed		0	1	Percentage Correct
Step 1	Not Retained	0	65	299	17.9
	Retained	1	42	895	95.5
		Overall Percentage			73.8

a. The cut value is .500

Statistically significant results in Phase I were used to establish and refine the qualitative questions for Phase II of this study. The overall theme and the two open-ended questions were informed by the quantitative results. *Similarity between the opened-ended persistence question and the retention question is linked to the fact that quantitative results for both included two of the same statistically significant predictive variables*. Additionally, it was the intention of the researcher to investigate persistence as a student measure and retention as an institutional measure in this component of the study. Thus, posing questions based on the quantitative findings and giving careful consideration to both persistence and retention provided a more holistic approach. The statistically significant variables for both persistence and retention included GPA (last semester or cumulative) and percent of courses completed or passed. In this study, persistence was viewed as a student measure and retention as an institutional measure based on the quantitative results. The Nominal Group Technique (NGT) was used to capture the participants' perspective and further examine the quantitative findings.

Phase II Qualitative Analysis (Nominal Group Technique)

Phase II of this study involved the analysis of qualitative data, which was collected from students who participated in a nominal group. Nominal group technique is very applicable in the decision-making process, especially in the problem-identification and solution-generating phases (Tague, 2004). According to the Centers for Disease Control and Prevention (2006) Evaluation Briefs, each group member is allowed full participation without group domination by individual(s) in a nominal group technique. Phase II (qualitative) addressed objectives three and four as follows:

Selection Process for Nominal Group Technique

Emails were sent to all URM students enrolled in the database during the Fall 2007-Spring 2010 time frame informing them of the opportunity to participate in this research project. Additionally, the director of minority affairs, the president of the National Society of Black Engineers (NSBE), and the administrative assistant of the Louis Stokes Louisiana Alliance of Minority Participation (LSLAMP) program assisted the researcher by communicating with students about the opportunity to participate voluntarily in this study.

The random selection process continued until 18 URM students who fit the group dynamics needed and were willing and available to participate were selected. The final nominal group was comprised of eleven African Americans, four Hispanics (the researcher was not able to identify five available Hispanic students within the allotted time of this study), and three Native American students. The classifications of the URM students selected for the nominal group included three freshmen, six sophomores, and nine juniors in to establish a double stratum. The double strata included race/ethnicity and classification. The focus of the nominal group application was to gain what Creswell (2003) refers to as multiple perspectives of the participants.

Directions to Nominal Group

The researcher met with 18 URM students in a meeting room at the regional university to conduct the nominal group session. The URM students were assigned numbers based on the order in which they signed in from 1 to 18 upon entering the nominal group session. For example, the first student was assigned number one and was given the envelope with number one written on it so that all data would be placed in the envelope that corresponds to the participant at the end of the qualitative data collection process. The participants were asked to sit at one of three sections of a table so that each group had an equal number of members. The procedures and guidelines for applying the nominal group technique were explained to the URM students in this study. It was the goal of the researcher to gain the following: ensure equal participation, commitment to answers or choices, eliminate peer pressure in rankings, prevent individual donation in groups, and gain team consensus.

Next, the central theme of the research was presented to the students: “What are the perceived factors that contribute to persistence and retention of undergraduate minority students in science, technology, engineering, and mathematics (STEM) disciplines at this regional university?” The researcher instructed the participants that two open-ended questions relevant to the aforementioned theme, the qualitative research objectives three and four, and most importantly the quantitative findings would be posed on persistence, then on retention. Each participant was given a card with the definition of persistence and retention as defined in the study to establish clarity of both terms. First, the persistence open-ended question in the NGT was conducted by the researcher.

Persistence (Nominal Group Technique)

The persistence open ended question was posed as follows: "Based on your experience in a STEM discipline, tell me what five factors, in list form, influence your ability to persist at this university?" Participants were given index cards and asked to label the top of them with the same number from (1-18) that was written on the top envelope. URM students were allotted 15-20 minutes to individually brainstorm their answers and list or briefly describe five responses to the persistence question posed by the researcher. There were a total of 90 (18 URM students x 5) responses. A volunteer from each group was assigned to write down verbatim all of the answers given by the group of students onto flip chart paper. Then, the researcher posted the 90 responses on flip chart paper onto the wall.

After each of the URM students viewed the answers, they were given an opportunity to ask questions to clarify and additional understanding about the responses, without criticizing. Clarification was given by the originator of the answers, as necessary, and then the researcher asked the entire nominal group to review all responses for duplication. There were a total of 36 duplications in the persistence responses. Duplications were removed using the strike through method and the remaining 54 responses (51 original + 3 combined) were alphabetized beginning with (a to z, then aa to zz, and aaa to bbb). Participants were instructed to place this index card with responses written on them in the envelope.

Next, a second index card was issued and participants were instructed to place their assigned number from (1-18) and the word “Final Persistence” at the top of the index card. These index cards were given the name “Final Persistence” because it would be used to aggregate the findings of the nominal group by the researcher. Nominal group members were asked to write the numbers (5, 4, 3, 2, and 1) in descending order on the index cards. Each group member was then asked to carefully revisit and consider all of the possible answers listed on the flip chart sheets for the persistence question and place the corresponding letter(s) in front of their response choice with five being the most important and one being the least important. Participants placed their response cards in an individual envelope following their individual top five ranking. All of the URM student envelopes were collected at the end of the persistence portion of the nominal group session. Then, the researcher addressed the retention open-ended question using the nominal group technique.

Retention (Nominal Group Technique)

The opened ended question for retention was the following: “Based on your experience in a STEM discipline, please list five campus resources or support services that influence your retention at this university?” The same format was followed in addressing the retention question. The URM student participants for this part of the nominal group compiled 90 responses to the retention question posed by the researcher. A segment of clarification and duplication was conducted. After the removal of 42 duplicates, the remaining 48 answers were posted and alphabetized from (a to z, then aa to vv). The nominal group participants wrote down the letter(s) of their final top five responses with five being the most important and one being the lesser important out of the 48 answers posted.

After releasing the students, the researcher aggregated the data from the 18 URM students, which included the responses to the open ended questions on persistence and then on retention. Using two excel spreadsheets, numbered (1 to 18) and alphabetized (a to aaa) for persistence and (a to vv) for retention, results of the top five were as listed below for both the persistence question and the retention question.

Rankings for Persistence and Retention Based on NGT

As it relates to the question on persistence, the following five responses received the highest ranking as to why URM students persist at a regional university based on 18 URM students who participated in the nominal group. Persistence being defined as all URM freshmen students who were continuously enrolled in STEM at a regional university from the Fall 2007 through Spring 2010 semesters.

1. Determination to be successful in life;

2. Financial security and Family members (both *tied at 21*);
4. God and Faith;
5. My own drive, Knowing that education will help me to be successful in life; and
6. Sense of accomplishment.

As it relates to the question on retention, the following five reasons received the highest ranking as to why URM students are retained through the next semester at a regional university based on 18 URM students who participated in the nominal group. Retention was defined as all URM students who remained enrolled at the same institution in a STEM discipline for at least one consecutive semester anytime between the Fall 2007 through Spring 2010 time frame.

1. Financial Aid;
2. Networking with other students;
3. Academic Rigor/TOPS;
4. Library accessibility; and
5. Enthusiastic professors.

Appendix C shows the entire aggregation of the persistence segment and Appendix D shows the entire aggregation of the retention segment of the nominal group for this study. All responses are listed in descending order based on ratings by URM students. The interpretation of the entire analysis is further discussed in the next section.

Interpretation of the Entire Analysis

In addressing the final section of the sequential explanatory design, which is an interpretation of the entire analysis, Creswell et al. (2003) asserts that the two methods are integrated during what is referred to as the interpretation phase of the study. In this study, this analysis is presented as a final discussion of the combined results as shown in Figure 6.

Quantitative Summary and Interpretation (Persistence)

The quantitative output for persistence, showed GPA ($p < .001$) and percentage of courses completed ($p = .006$) as statistically significant. The statistical interpretation for this study revealed that URM student with higher GPA and who had lower percentage of and courses dropped are more likely to persist in STEM disciplines at this regional university.

Quantitative Summary and Interpretation (Retention)

The quantitative output for retention, showed academic rigor ($p = .015$), undergraduate cumulative GPA ($p < .001$), the percentage of classes completed ($p < .001$), and the percentage of classes passed ($p = .01$) were statistically significant. Underrepresented minority students, who completed an academically rigorous curriculum in high school, are more likely to be retained in STEM disciplines because these students must maintain passing grades in college to keep their TOPS scholarship. Additionally, URM students with higher cumulative GPAs, courses completed and successfully passed classes also show improved rates of retention. In the retention data, the composite score for ACT was ($p = .786$).

Qualitative Summary and Interpretation (Persistence)

The results of the top five persistence responses as ranked by URM students in the nominal group included the following: (a) determination to be successful in life, (b) financial security, (c) family members, (d) God and faith, and (e) knowing that education is a key to success, respectively 30, 21, 21, 20, and 15. Self-determination, which ranked the highest among the URM responses, received a ranking score of 30 and has been linked to the theory of self-efficacy. For example, Jordan, Sorby, Amato, Donahue (2007) contend "Increasing the awareness of engineering self-efficacy constructs could potentially improve persistence and sense of belonging for minority students in engineering" (p. 1). Also, financial security and family members were tied with a ranked score of 21 as contributors to URM student persistence. God and faith ranked high with a ranked score of 20 in relation to persistence but the importance of education as a key to success was given a score of 15 among URM participants in this study. Based on these findings it is evident that URM students value success, but strongly consider factors other than education alone as contributors to it. As it relates to persistence, the researcher viewed these responses as student measures as illustrated in the conceptual framework (see Figure 1)

Qualitative Summary and Interpretation (Retention)

The top five retention responses of URM students in the nominal group as related to campus resources or support services included financial aid, networking with other students, academically rigorous curriculum, library accessibility, and enthusiastic professors with ratings of 40, 23, 22, 19, and 18 respectively. Social integration has been shown to be a key contributor in the literature to retention. According to the University of Southern Nevada (2011),

> Studies show that students who work on campus succeed at a far higher rate than those who do not. This is because students who work on campus know many staff

> and faculty members they can turn to for help in achieving their educational goals. (p. 1)

College students, who have work-study jobs (a component of social integration), tend to have more time to focus on academics because they are limited to the number of hours that they can work weekly. Networking with other students rated high with a ranked score of 23 which is supported in the literature both as social integration and as a best practice for test preparation (Tinto, 1999).

Quantitative and Qualitative Integration

The following are some of the ways the qualitative results helped to explain the quantitative findings: Academically rigorous curriculum, financial aid, social integration, and course navigation. In the quantitative section of this study as it relates to retention, academic rigor was statistically significant at ($p = .015$). In the qualitative section of this study as it relates to retention, academic rigor was ranked the third highest support service listed by the URM students in the nominal group. In both the persistence and the retention section of this study the variable GPA was statistically significant. In the persistence data, GPA was statistically significant ($p < .001$) and for the retention section, GPA was statistically significant ($p < .001$). In the persistence section of the nominal group, URM students' results ranked the need for education to be successful as the fifth highest response. In the retention section, a good GPA could be linked to all five of the top five ratings. Financial aid and academic rigor/TOPS are both earned semester-by-semester and based on a student's GPA. A student who takes advantage of networking through study groups with other students as well as accessing the library could more than likely experience a higher GPA. Additionally, enthusiastic professors could be a motivational factor, which enable students to earn higher grades.

Lastly, in the persistence section, the percent of classes completed ($p = .006$) was statistically significant. The retention section revealed that the percentage of classes completed ($p < .001$) and the percent of classed passed ($p = .01$) were statistically significant. Padilla (1999) focused on the need for minority students to possess both theoretical and heuristic knowledge. He posits that whereas theoretical or book knowledge is important, heuristic knowledge or knowing how to successfully navigate post-secondary education (PSE) is equally important for college graduation. For, example, knowing when to drop a class before the final grade is averaged into the cumulative GPA of a student so that the student can adequately focus on remaining courses is crucial toward college success.

The nominal group listed some of the heuristic knowledge needed to navigate barriers of post secondary education such as building a support system (i.e., family members, God and faith, financial aid, networking with other students, library accessibility, enthusiastic professors); joining clubs, for example National Society of Black Engineers (NSBE), Louis Stokes Louisiana Alliance for Minority Participation (LS-LAMP), and Student Support Services Program. Additionally, Padilla (1999) contends that students should increase independence by making their own decisions. In the persistence ranking for the URM nominal group, the number one response was the students' determination to be successful in life or internal locus of control. Qualitative findings did reveal some correlations as well as further explain some of the statistically significant results found in the quantitative section of this study.

Summary

The quantitative and qualitative analysis presented in this chapter reveals several significant predictors for URM student success in STEM disciplines. Interestingly, one of the quantitative predictors, financial aid, was not statistically significant in Phase I, but the nominal group ranked it as the top predictor of their retention success. The quantitative analysis resulted in identifying five factors that were statistically significant. Additionally, the URM students in the nominal group ranked their top five persistence and retention responses. Chapter V presents the findings, conclusions, and recommendations for this study.

CHAPTER V

DISCUSSION

This chapter provides a recap of this mixed methods study using the sequential explanatory design. Included are an overview of the study, major findings, and conclusions and the implications. In addition, the limitations, and recommendations for further studies are presented based on the study's outcomes.

Overview of the Study

The purpose of the study was to identify specific factors that contribute to persistence and retention of underrepresented minority (URM) students enrolled in undergraduate STEM disciplines at a regional university during the 2007-2010 semesters. Research and pertinent data obtained in this study is vital to the regional university's stakeholders' understanding of specific factors contributing to URM (African American, Hispanics, and Native American) student success in STEM disciplines. If there is any verity to Slaughter and McPhail's (2007) prediction that minority student participation will increase in PSE from 32% to 38% by 2025, then understanding success factors for URM in STEM is critical. However, the existing number of URM students in STEM disciplines remains low as the U.S. STEM workforce demand continues to rise.

In order to capture the complexities of the factors that lead to URM student persistence and retention in STEM disciplines, the investigator employed a sequential explanatory methodology in two distinct phases. In Phase I (quantitative), archival data was collected and analyzed from two of the institution's databases (ISIS and SAM). Two separate datasets (persistence and retention) were complied. The persistence dataset involved the archival data of (196) URM (freshmen cohort) students and the retention dataset consisted of total of (687) URM (freshmen, sophomores, juniors) students. Two separate logistic regression analyses were generated by SPSS (16.0) to gather the quantitative findings for this study.

In Phase II, (qualitative) data was collected from a nominal group comprised of 18 URM (eleven African American, four Hispanic, and three Native American) students enrolled at the university. The classifications of the participants in the nominal group included three freshmen, six sophomores, and nine juniors. Nominal group technique was used to gain what Creswell (2003) refers to as the multiple perspectives of the participants. The major findings are discussed in the following section.

Demographic Observations

As it relates to gender, a higher percentage of females (over 43%) in this study majored in STEM disciplines. Two of the main reasons extracted from the data for the higher percentage of female student enrollment in STEM at this university are the following: (a) biology, by far, has the largest percentage of URM student enrollment in STEM; (b) over 82% of the biology STEM majors were female students; however, this percentage also includes students who may be tracked for pre-med, which will no longer classify them as STEM majors. According to Business-Higher Education Forum (2006), “women remain underrepresented in STEM fields” (p. 1). It was concluded that the number of URM female students seemed higher compared to national averages. However after matriculating in biology, many of these female students enter medical fields and are no longer identified as STEM majors. It is therefore recommended that the regional university create incentives to attract female students who will graduate and remain a part of the STEM talent pool.

In the area of race/ethnicity, African American students had the highest enrollment in the persistence and retention data. Hispanic students had a strong representation in the area of engineering although fewer in number. Finally, Native American students' total enrollment in STEM disciplines at this university seemed very low considering the close proximity of tribal communities to this institution. It was concluded that the regional university has a diverse population of students but lacks proportional representation for both its Hispanic and Native American students in STEM. It is recommended that university recruiters target these two minority populations in order to satisfy its goal of diversity, which is a part of its overall mission.

Quantitative Findings Discussed

The quantitative findings, conclusions, and recommendations that contributed to URM student persistence and retention datasets are discussed in this section. The findings included GPA, percent of hours completed, academic rigor, and percent of hours passed.

Grade Point Average (GPA)

Grade point averages at both secondary and PSE levels had explanatory power as predictors of STEM persistence in this study. Therefore, the researcher concludes that GPA serves as predictor of persistence for first-time URM freshmen as well continuing college students in STEM. High school GPA was significant for the persistence data but not for the retention data. It is recommended that knowing the high school GPA of URM students could help this university with admissions decisions and course placements for first time freshmen students. According to Brown, Hershock, Finelli, and Neal (2009), "Students should be encouraged to view their performance as a measure of their effort, not their innate ability in STEM" (p. 5). The college GPA, if carefully monitored, can help students in their career paths as well as college advisors with applying interventions in a timely manner to improve URM student persistence.

Percent of Classes Completed

Overall, in this study, students who registered and completed a higher percentage of classes were more likely to persist. It is important to note that the percent of classes completed in this study may have included some courses for which a URM student made an “F.” The percentage of classes completed Harmon and King (1985) and Padilla (1992) posit the need for minority students to gain both theoretical (book) and heuristic (experiential) knowledge is critical to persistence. It is concluded that acquiring the knowledge of how to navigate barriers in PSE is crucial for URM students’ academic success in STEM disciplines. It is recommended that professors and education departments within universities could collaborate on creating a tool kit for STEM majors and seek effective pedagogical approaches to instruct URM students at the undergraduate level. According to Hrabowski (2011), “An urgent task for colleges and universities is to redesign first-year STEM classes to encourage active learning and collaboration…[which] could be particularly helpful in reducing the high rate of attrition for many minorities in STEM subjects” (p. 125).

In the retention dataset, those contributing the most to URM student success in STEM were the following: (a) an academically rigorous curriculum, (b) cumulative GPA, (c) percent of classes completed, and (d) percent of classes passed. Since the researcher has already addressed the variables (GPA and percent of classes completed), the discussion will focus on the contributions of an academically rigorous curriculum and the percent of classes passed to URM student success in STEM.

Academically Rigorous Curriculum

It was interested to note that in the persistence dataset, academic rigor was not statistically significant. However, academic rigor was a strong STEM predictor in the retention dataset. It was concluded that an academically rigorous curriculum enabled URM students to more successfully matriculate and to be retained in STEM disciplines. Increased student retention is necessary when approximately 50% of the students who major in STEM fields ultimately switch out or drop out of STEM undergraduate programs and do not earn STEM degrees and 35% switch majors (Daempfle, 2003; National Center for Education Statistics, 2009). It is recommended that professors and education departments within universities could collaborate on creating more effective pedagogical approaches to instruct URM students at the undergraduate level. According to Hrabowski (2011),

> An urgent task for colleges and universities is to redesign first-year STEM classes to encourage active learning and collaboration… and it could be particularly helpful in reducing the high rate of attrition for many minorities in STEM subjects. (p. 125)

Percent of Classes Passed

The percent of classes passed with a letter grade higher than an “F” was significant. As expected, URM students who passed more classes or dropped fewer classes in STEM had higher retention rates. Passing gatekeeper courses (i.e., calculus, chemistry, and physics) is critical for URM students to enter advanced classes in STEM. Passing classes is important because it equates to greater chances of college graduation, gainful employment, and income opportunities. Therefore, it is concluded that URM students' ability to earn a passing grade (especially in gatekeeper courses) without having to drop classes equate to higher rates of retention in STEM disciplines. It is recommended that under-represented minority students enrolled in STEM disciplines receive early interventions especially to overcome barriers in gatekeeper courses and to enhance self-efficacy. According to Lent, Brown, Schmidt, Brenner, Lyons, and Treisman (2003), academic research among STEM undergraduates has associated positive self-efficacy with increased persistence and retention. The qualitative findings are addressed in the next paragraph as a result of the nominal group.

Qualitative Findings Discussed

The top five URM student responses to the researcher's question, "Based on your experience in a STEM discipline, tell me what five factors, in list form, influence your ability to *persist* at this university?" are listed below. It should be noted that there are actually six URM student responses in the ranking for persistence due to two factors which were scored equally by the nominal group participants:

1. Determination to be successful in life;
2. Financial security and Family members (both *tied at 21*);
4. God and Faith;
5. My own drive, Knowing that education will help me to be successful in life; and
6. Sense of accomplishment.

Factors 1, 2, 4, 5, and 6 above, although different, are all related to self-efficacy stemming from both internal and external locus of control. It appears that students in the nominal group viewed success as the result of their own drive and motivation. God and

Faith was an outlier but considered to be a key contributor to the perceived persistence of the nominal group participants in this study. It was concluded nominal group participants had a circle of influence, which was tight knit and small because it centered on the students self motivation, their family, and their faith. It is recommended that the institution celebrate the uniqueness of the individual cultural capital (family, spirituality, and beliefs) of the minority students and their need for holistic education.

The top five responses to the researcher's question, "Based on your experience in a STEM discipline, please list five campus resources or support services that influence your retention at this university?" are listed below:

1. Financial Aid;
2. Networking with other students;
3. TOPS (academically rigorous curriculum);
4. Library accessibility; and
5. Enthusiastic professors.

Although financial aid was not significant in the quantitative results, URM students, who participated in the nominal group, ranked financial aid as the highest contributor to retention. It is concluded that URM students place a high value on the financial assistance they receive while enrolled in college. It is recommended that the university continues to support the unmet needs of minority students and seek NSF funding to supplement their education through merit based grants and research projects.

An academically rigorous curriculum was not significant in the persistence data, but it was significant in the retention data. Interestingly, the URM students in the nominal group ranked TOPS (academic rigor) as the third highest contributing factor to retention.

It is important to note that students who complete the academically rigorous curriculum in high school and earn the states average ACT score (based on Louisiana standards) are eligible for the merit based TOPS scholarship. This scholarship includes paid college tuition and may offer a stipend of ($400 to $800 per semester) for students with higher grade point averages and/or ACT scores. It is concluded that URM students value the academic rigor and the financial merit based award, which is included. It is recommended that policy makers in Louisiana continue to fund the TOPS scholarship program, while not lowering its academic standard.

Social integration was found to be of marginal significance *only* in the persistence data but had a negative beta. URM students, who participated in the nominal group, ranked networking with other students, library accessibility, and enthusiastic professors as three of the top five contributors to URM student retention. In a study conducted by Chang, Sharkness, Newman, and Hurtado (2010), similar findings revealed the significance of social integration of URM student engagement in STEM based organizations or clubs.

A large part of the students' discussion during the response clarification was centered on campus organizations. The researcher observed the students momentarily digressing during the clarification process to share information on the various programs and the benefits. Students exchanged contact information for further follow-up on these organizations. It was observed, that students became actively involved in networking with each other during the nominal group. This form of social networking demonstrated what Padilla (1999) refers to as heuristic knowledge. Thus, it was not surprising to the researcher that social networking was in the top five final rankings. It was concluded the

URM students in the nominal group viewed social integration (networking) as very importing to STEM success. It is therefore recommended URM students take advantage of opportunities for social networking (study groups, STEM organizations on campus such as NSBE, LSAMP, Cajun-Bot, and others), which can promote personal growth, development, and awareness.

Faculty involvement has been associated in the literature with improved academic performance (Astin, 1985; Boudreau & Kromrey, 1994; Carini, Kuh, & Klien, 2006) and is also a part of URM social integration. URM student were very vocal as to how much they appreciated didactic professors especially in the gatekeeper courses (physics, calculus). It was concluded by the URM student input and ranking of enthusiastic professors that they strongly considered the teaching styles of their professors as an important part of retention. It is recommended that the students' evaluations of faculty should be seriously scrutinized in order to establish a more effective 'campus climate' conducive to learning and forming positive professional rapports between Faculty and students.

Limitations of the Study

The regional university has selective admissions requirements, which classified the types of underrepresented minorities allowed to participant in this study. This study was delimited to underrepresented minority students majoring in STEM at a single regional university as opposed to all STEM majors, race/ethnicity, and during the Fall 2007-Spring 2010 time frame. This study was a micro study and the findings are not necessarily generalizable as they reflect the findings based only on the participants of this regional university. Hispanic and Native American student participation were minimal based on their low enrollment at this regional university, which infers that the distribution among race/ethnicity had some limitations. As it related to the eighteen students in the nominal group, four, or 22% of the participants, were Hispanic students and three, or 16.7%, were Native American students. In the qualitative nominal group phase of this study, although it was the intention of the researcher to get five Hispanic participants, only four were available to take part based on class schedules and other responsibilities. It was uncertain as to whether URM students in the nominal group technique gave factual responses based on personal feelings or beliefs and were not swayed by participant domination. Limitations may also result from reliability issues regarding the qualitative open-ended questions used in the nominal group technique.

Recommendations for Future Research

The results of this study indicate further research is needed to identify more of the pre-college variables that could contribute to increased persistence and retention or URM students in undergraduate STEM disciplines. The researcher suggests conducting two separate studies or a longitudinal ex-post factor combined study. One of studies would solely focus on persistence as an independent variable and the other study would solely focus on retention as an independent variable. It is also recommended that in the (qualitative) Phase II of the research more probing is conducted by the researcher to better understand the specific factors that relate to persistence and retention of the individual racial/ethnicity (African American, Hispanic, Native American) groups within the minority population. If this study is replicated, the researcher suggests using Improved Nominal Group Technique. According to Mycoted (2008), Improved Nominal Group Technique "is an extension of Nominal Group Technique described by William

Fox with an additional pre-meeting stage which ensures full anonymity of contributions and speeds up transcription phases" (p. 1). The researcher discovered the Improved Nominal Group after he had conducted the (qualitative) Phase II of this study.

It is recommended that logistic regression be applied using the "stepwise" method for data input though the use of SPSS. The use of stepwise or another statistical model could allow for an even greater examination of specific individual contributions of factors, which impact URM persistence and retention in STEM. Instead of relying on the limitations of variables in the databases (i.e., social integration and financial aid), the researcher could develop a survey with selected factors based on the literature.

Conclusion

If URM students' persistence and retention continue to decrease in STEM disciplines, U.S. institutions and the nation as a whole will continue to lag behind in human capital and productivity. Therefore, it becomes necessary that institutions be prepared to meet the challenge of preparing minority students to successfully navigate STEM disciplines. Toliver (2005) asserts that all stakeholders and policymakers must understand that retention is not just a minority problem; it is an institutional challenge.

On April 20, 2010, the British Petroleum (BP) oil spill caused a national uproar as tons of gallons of oil leaked into the Gulf of Mexico causing a serious loss of oil and devastation to coastal Louisiana, Mississippi, and Florida and a national uproar. In a personal communication with Dr. Janice Nix-Victorian on April 19, 2011, it was realized that United States loses vast amounts of human capital from its STEM pipeline and yet it appears to be a quiet crisis.

Approximately 4 million U.S. students who entered 9th grade in 2001, 2,799,250 graduated in the Spring of 2005. However, only 166,530 are projected to graduate in STEM during the 2011 academic year. It is my opinion that this percentage of projected 2011 STEM graduates is but a “drip” of human capital compared to the more than 4 million that entered high school in 2001. If the entire projected 2011 STEM population is a drip, then the projected population of URM students graduating within the STEM pipeline for this period, as shared by Dr. Yanez, equates to but a *vapor*. Indeed, the United States must make better use of its URM human capital and more aggressively prepare these students to fully compete in its STEM revolution.

APPENDIX A

PERSISTENCE DATA SET

GENDER	MAJOR	# of Students
Female	Animal Science, Concentration	2
	Biology	65
	Chemical Engineering	1
	Chemistry	4
	Computer Science	9
	Elec Engr, Computer Engr	2
	Industrial Technology	2
	Mathematics	1
	Mechanical Engineering	1
	Microbiology	3
	Petroleum Engineering	1
	Physics	1
Female Total		92
Male	Agribusiness, Concentration	1
	Animal Science, Concentration	1
	Biology	21
	Chemical Engineering	4
	Chemistry	1
	Civil Engineering	5
	Computer Science	21
	Elec Engr, Computer Engr	9
	Electrical Engineering	11
	Geology	1
	Industrial Technology	13
	Mathematics	1
	Mechanical Engineering	10
	Petroleum Engineering	5
Male Total		104
Grand Total		196

APPENDIX B

RETENTION DATA SET

GENDER	MAJOR	# of Students
Female	Agribusiness, Concentration	1
	Animal Science, Concentration	9
	Biology	198
	Chemical Engineering	11
	Chemistry	11
	Civil Engineering	3
	Computer Science	31
	Elec Engr, Computer Engr	9
	Elec Engr, Telecomm Engr	1
	Electrical Engineering	4
	Geology	1
	Industrial Technology	8
	Mathematics	3
	Mechanical Engineering	4
	Microbiology	9
	Petroleum Engineering	4
	Physics	1
	Plant Science, Concentration	1
Female Total		309
Male	Agribusiness, Concentration	3
	Animal Science, Concentration	1
	Biology	59
	Chemical Engineering	20
	Chemistry	4
	Civil Engineering	18
	Computer Science	79
	Elec Engr, Computer Engr	41
	Elec Engr, Telecomm Engr	1
	Electrical Engineering	35
	Geology	1
	Industrial Tech, Associate	1
	Industrial Technology	60
	Landscape& Horticulture Mgmt	1
	Mathematics	7
	Mech Engineering, CAD/CAM	1
	Mechanical Engineering	44
	Microbiology	5
	Nat. Resources&Envir Quality	1
	Petroleum Engineering	18
	Resource Biology/Biodiversity	1
Male Total		401
Grand Total		710

APPENDIX C

FINAL OUTPUT OF NOMINAL GROUP QUESTION 1 (PERSISTENCE)

Student Responses – (Q1) Persistence

Answers

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Totals
M	my determination to be successful in life	5	4	3	5			3			5				5					**30**
A	financial security		2			3		1	2	5			5				3			**21**
CC	family members		5	5				4				3						4		**21**
GG	God and my faith	3									2	5		5		5				**20**
H	my own drive, knowing that school will help me be successful in life					2		5	3								5			**15**
C	sense of accomplishment												2				4	5	3	**14**
P	my ability to do anything I set my mind to do				4		5							4		1				**14**
T	give my future kids a better life than me	1			3		2			1	3	2					2			**14**
B	job stability/security									4	4		4							**12**
W	to one day change the world								5								1	2	2	**10**
OO	just wanting to know that I can finish something I start				1	5									4					**10**
UU	self-motivation						3								2				5	**10**
N	career satisfaction		3	1		1			1				3							**9**
KK	knowing that my parents and family have faith in me to succeed and be the best				2	4					1				1					**8**
SS	mom and grandmother motivation/my family looks up to me						4									2				**6**
TT	determination													2	3					**5**
K	successful father			4																**4**
O	first in family in college						1									3				**4**
R	begin a tradition in my family	4																		**4**
V	I have already invested time and money									3								1		**4**
X	to make my loved ones proud								4											**4**
AA	only one in my family to be in college															4				**4**
DD	my past life influences me											4								**4**
ZZ	I love biology																	3	1	**4**
AAA	natural intelligence																		4	**4**

Student Responses – (Q1) Persistence

Answers

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Totals
WW	positive mind set													3						**3**
E	opportunity for higher learning			2																**2**
I	availability of teachers and resources needed							2												**2**
S	mom									2										**2**
Z	that I'm minority	2																		**2**
D	so parents could be proud												1							**1**
J	the want to achieve											1								**1**
II	financial aid (GI Bill)		1																	**1**
LL	hometown (away)													1						**1**
F	requirement for TOPS																			**0**
G	a promise to my dad before he passed																			**0**
L	location																			**0**
Q	foresight																			**0**
U	friends																			**0**
Y	challenge of surviving college																			**0**
BB	the STEM program (personnel)																			**0**
EE	pride																			**0**
FF	long life thought to study in major																			**0**
HH	grandfather																			**0**
JJ	access of info in UL Lafayette																			**0**
MM	self-expression																			**0**
NN	status that comes with the job																			**0**
PP	know that not too many of my former classmates in high school are even doing anything																			**0**
QQ	first university and feel at home																			**0**
RR	the desire to help people on another level																			**0**
VV	economic info and the importance to pursue a degree in today's economy																			**0**
XX	keep family education tradition																			**0**
YY	good member of society																			**0**
BB	proper preparation for exams																			**0**

APPENDIX D

FINAL OUTPUT OF NOMINAL GROUP QUESTION 2 (RETENTION)

Student Responses - (Q2) Retention

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Totals
A	financial aid	4				4	5			5	4	5	5			3			5	**40**
Y	networking with other students	2		3		5			2	4						2	3		2	**23**
J	TOPS/Financial Assistance				5		4	5	3					5						**22**
L	library accessibility							4	1		2				5		5	2		**19**
BB	enthusiastic professors		5	5		2			5										1	**18**
F	quality of education		3		2				4		5									**14**
P	free tutoring	3	1	1	3			2					2							**12**
N	access of computer labs				4	1				2									4	**11**
V	NSBE						3									5				**8**
VV	study group within roommates and friends (competition)																	5	3	**8**
E	good relationship with professors					3				3										**6**
K	counselor			4										2						**6**
KK	study lab (Declouet)										3	3								**6**
S	organizations within my major	5																		**5**
PP	mentor program											2		3						**5**
B	involved mentors												4							**4**
C	knowledgeable/involved mentors				1								3							**4**
D	LS-LAMP Program													4						**4**
I	VA Office		4																	**4**
T	minority professors motivation															4				**4**
X	working on campus																	4		**4**
Z	study groups in Lee Hall														4					**4**
JJ	Upward Bound Programs/success programs											4								**4**
UU	Madison (Society of Petroleum Engineering)																4			**4**
G	campus life										1						2			**3**
AA	going to meet teachers during their office hours																	3		**3**
CC	online databases from library							3												**3**

Answers

Student Responses - (Q2) Retention

Answers		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Totals
HH	examples of old tests						2	1												**3**
OO	dorms/apartments														3					**3**
M	seeing the projects of upper classmen			2																**2**
O	student support services											1					1			**2**
U	motivational workshops	1														1				**2**
DD	free parking		2																	**2**
SS	family aid														2					**2**
R	Moodle									1										**1**
W	support from few professors						1													**1**
EE	textbook rentals												1							**1**
FF	pre-professional society																	1		**1**
II	transportation/living arrangements													1						**1**
R	fraternity/sorority														1					**1**
H	circle K organization																			**0**
Q	access of copy machines																			**0**
GG	UL Lafayette staff																			**0**
LL	LAMP Trio																			**0**
MM	Phi Beta Sigma																			**0**
NN	student union																			**0**
QQ	safe environment																			**0**
TT	petroleum engineering computer lab																			**0**

APPENDIX E

PERSISTENCE CODING FOR EXCEL AND SPSS

VARIABLE	CATEGORY	VALUE
1) **PERSISTENCE** (dependent variable)	No	0
	Yes	1
2) CLID	Email	Computer Generated
3) ACT Composite Score		Computer Generated
4) ACT English		Computer Generated
5) ACT Math		Computer Generated
6) ACT Reading		Computer Generated
7) ACT Science		Computer Generated
8) Ethnicity	African American	1
	Hispanic American	2
	Native American	3
9) Gender	Female	0
	Male	1
10) Classification	Freshman	1
	Sophomore	2
	Junior	3
11) High School GPA		Computer Generated
12) First Time Freshman	No	0
	Yes	1
13) Academic Rigor/TOPS	No	0
	Yes	1
	Yes	1
14) Both Pell and Loan	No	0
	Yes	1
15) GPA (Last Semester Enrolled)		Computer Generated
16) Social Integration (Campus Residency and Work Study)	No	0
	Yes	1
17) Percent of Classes Completed (Mean Registration – Mean Completed)		Computer Generated
18) Fall 2007 Term Hours Registered		Computer Generated
19) Fall 2007 Term Hours Completed		Computer Generated
20) Fall 2007 Undergrad Cumulative GPA		Computer Generated
21) Spring 2008 Term Hours Registered		Computer Generated
22) Spring 2008 Term Hours Completed		Computer Generated
23) Spring 2008 Undergrad Cumulative GPA		Computer Generated
24) Fall 2008 Term Hours Registered		Computer Generated
25) Term Hours Completed		Computer Generated
26) Fall 2008 Undergrad Cumulative GPA		Computer Generated
27) Spring 2009 Term Hours Registered		Computer Generated
28) Spring 2009 Term Hours Completed		Computer Generated
29) Spring 2009 Undergrad Cumulative GPA		Computer Generated
30) Fall 2009 Term Hours Registered		Computer Generated
31) Fall 2009 Term Hours Completed		Computer Generated
32) Fall 2009 Undergrad Cumulative GPA		Computer Generated
33) Spring 2010 Term Hours Registered		Computer Generated
34) Spring 2010 Term Hours Completed		Computer Generated
35) Spring 2010 Undergrad Cumulative GPA		Computer Generated

APPENDIX F

RETENTION CODING FOR EXCEL AND SPSS

APPENDIX G

VARIABLE	CATEGORY	VALUE
1) **RETENTION** (dependent variable)	No	0
	Yes	1
2) CLID	Email	Computer Generated
3) ACT Composite Score		Computer Generated
4) ACT English		Computer Generated
5) ACT Math		Computer Generated
6) ACT Reading		Computer Generated
7) ACT Science		Computer Generated
8) Ethnicity	African American	1
	Hispanic American	2
	Native American	3
9) Gender	Female	0
	Male	1
10) Classification	Freshman	1
	Sophomore	2
	Junior	3
11) High School GPA		Computer Generated
12) Non-First Time Freshman	No	0
	Yes	1
13) Academic Rigor/TOPS	No	0
	Yes	1
14) Pell Grant, Loan and University scholarship	No	0
	Yes	1
15) GPA (Undergrad Cumulative)		Computer Generated
16) Social Integration (Campus Residency and Work Study)	No	0
	Yes	1
17) Percent of Classes Completed (Mean Registration – Mean Completed)		Computer Generated
18) Percent of Classes Passed (Mean Completed – Mean Earned)		Computer Generated
19) Fall 2007 Term Hours Registered		Computer Generated
20) Fall 2007 Term Hours Completed		Computer Generated
21) Fall 2007 Undergrad Cumulative GPA		Computer Generated
22) Spring 2008 Term Hours Registered		Computer Generated
23) Spring 2008 Term Hours Completed		Computer Generated
24) Spring 2008 Undergrad Cumulative GPA		Computer Generated
25) Fall 2008 Term Hours Registered		Computer Generated
26) Term Hours Completed		Computer Generated
27) Fall 2008 Undergrad Cumulative GPA		Computer Generated
28) Spring 2009 Term Hours Registered		Computer Generated
29) Spring 2009 Term Hours Completed		Computer Generated
30) Spring 2009 Undergrad Cumulative GPA		Computer Generated
31) Fall 2009 Term Hours Registered		Computer Generated
32) Fall 2009 Term Hours Completed		Computer Generated
33) Fall 2009 Undergrad Cumulative GPA		Computer Generated
34) Spring 2010 Term Hours Registered		Computer Generated
35) Spring 2010 Term Hours Completed		Computer Generated
36) Spring 2010 Undergrad Cumulative GPA		Computer Generated

CERTIFICATE OF COMPLETION FOR WORKING WITH HUMAN SUBJECTS

Certificate of Completion

The National Institutes of Health (NIH) Office of Extramural Research certifies that **Sidney Mitchell** successfully completed the NIH Web-based training course “Protecting Human Research Participants”.

Date of completion: 11/04/2010

Certification Number: 564371

APPENDIX H

HUMAN SUBJECTS: NOTICE OF COMMITTEE ACTION

THE UNIVERSITY OF SOUTHERN MISSISSIPPI

Institutional Review Board

118 College Drive #5147
Hattiesburg, MS 39406-0001
Tel: 601.266.6820
Fax: 601.266.5509
www.usm.edu/irb

HUMAN SUBJECTS PROTECTION REVIEW COMMITTEE
NOTICE OF COMMITTEE ACTION

The project has been reviewed by The University of Southern Mississippi Human Subjects Protection Review Committee in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services (45 CFR Part 46), and university guidelines to ensure adherence to the following criteria:

- The risks to subjects are minimized.
- The risks to subjects are reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered regarding risks to subjects must be reported immediately, but not later than 10 days following the event. This should be reported to the IRB Office via the "Adverse Effect Report Form".
- If approved, the maximum period of approval is limited to twelve months. Projects that exceed this period must submit an application for renewal or continuation.

PROTOCOL NUMBER: **10111604**
PROJECT TITLE: **Factors that Contribute to Persistence and Retention of Minority Undergraduate Students in Science, Technology, Engineering and Mathematics (STEM)**
PROPOSED PROJECT DATES: **11/15/2010 to 05/01/2011**
PROJECT TYPE: **Dissertation**
PRINCIPAL INVESTIGATORS: **Sidney Kirk Mitchell**
COLLEGE/DIVISION: **College of Science & Technology**
DEPARTMENT: **DEWD**
FUNDING AGENCY: **N/A**
HSPRC COMMITTEE ACTION: **Expedited Review Approval**
PERIOD OF APPROVAL: **11/29/2010 to 11/28/2011**

Lawrence A. Hosman
Lawrence A. Hosman, Ph.D.
HSPRC Chair

12-01-2010
Date

APPENDIX I

UL LAFAYETTE: APPROVAL OF DATA COLLECTION

FA10-25_USM_Approval_form[1]
8/23/01

MEMORANDUM	**The University of Louisiana at Lafayette**
	Institutional Review Board

IRB 00001474 **FWA00000758**

to:	**Mr Sidney K. Mitchell, Veterans Upward Bound, UL Lafayette**
from:	**Nicole Müller, DPhil, Professor, IRB Chair**
re:	**Approval of Proposal** (FA10-25 USM) "Factors that Contribute to Persistence and Retention of Minority Undergraduate Students in Science, Technology, Engineering, and Mathematics (STEM)."
date:	**November 24th, 2010**

Your application for IRB review of the study at the Level of: ___XX___ Expedited ___ Full has been approved by the U.L. Lafayette Institutional Review Board.

Congratulations, you may begin collecting data.

Your approval is for a single year, and if your data collection extends beyond one year from the approval date on the application, then resubmission of the full application with any changes in subjects, data collection procedures or forms, or treatments specified will be necessary. If you make any changes in your data collection procedures, treatments, or subject population before the end of the approval period, please inform the IRB Chair in writing since substantive changes in the project will need to be reviewed. (Form accompanies this approval)

If there is any type of injury to any participant of this research you must notify the IRB within 24 hours. Failure to inform the IRB of injury to participants is grounds for suspension of the research.

When your project is complete, please contact the IRB chair to document the completion of the study using the enclosed form.

We wish you well with your project. If you have any questions about revisions and the need for re-review, please contact me.

from the desk of...
Nicole Müller, DPhil
University of Louisiana at Lafayette
P.O. Box 43170
Lafayette, LA 70504-3170
(337) 482-6489 email: nmueller@louisiana.edu

APPENDIX J

AUTHORIZATION TO PARTICIPATE IN RESEARCH PROJECT

ORAL PRESENTATION

Consent is hereby given to participate in the study titled:

Factors that Contribute to Persistence and Retention of Minority Undergraduate Students Science, Technology, Engineering, and Mathematics (STEM)

1. **Purpose:** The purpose of this study is to identify factors that contribute to persistence and retention of minority undergraduate students enrolled in Science, Technology, Engineering, and Mathematics (STEM) disciplines at a regional university.

2. **Description of Study:** During the qualitative phase of this study, a stratified random sample of participants will be identified then asked to take part in this study. These students will be asked to take part in a nominal group of 18-24 minority undergraduate students enrolled in STEM disciplines at a regional university for a maximum of three hours. The nominal group technique will be administered exclusively by the researcher.

3. **Benefits:** The potential benefits of this study include the opportunity for students, faculty, administrators, and other stakeholders to better understand specific factors leading to persistence and retention for minority undergraduate students enrolled in STEM disciplines at a regional university.

4. **Risks:** Participation in this study poses no known risks or hazards.

5. **Confidentiality:** Describe the extent, if any, to which confidentiality of records identifying the participant will be maintained.

6. **Participant's Assurance:** Whereas no assurance can be made concerning results that may be obtained (since results from investigational studies cannot be predicted) the researcher will take every precaution consistent with the best scientific practice. Participation in this project is completely voluntary, and participants may withdraw from this study at any time without penalty, prejudice, or loss of benefits. Any questions or concerns about rights as a research participant should be directed to the Chair of the Institutional Review Board, The University of Southern Mississippi, 118 College Drive #5147, Hattiesburg, MS 39406-0001, (601) 266-6820. Additionally, the University of Louisiana at Lafayette, P.O. Box 43170, Lafayette, Louisiana 70504; Dr. Nicole Muller (IRB Chair), (337) 482-6489 and/or Sidney Mitchell at (337) 241-4065. Participants will be given a copy of the consent documentation for their records.

______________________________________ __________________

Signature of Person Giving Oral Presentation Date

APPENDIX K

AUTHORIZATION TO PARTICIPATE IN RESEARCH PROJECT

THE UNIVERSITY OF SOUTHERN MISSISSIPPI
AUTHORIZATION TO PARTICIPATE IN RESEARCH PROJECT
(Short Form - to be used with oral presentation)

Participant's Name ______________________________

Factors that Contribute to Persistence and Retention of Minority Undergraduate Students Science, Technology, Engineering, and Mathematics (STEM)

All procedures and/or investigations to be followed and their purpose, including any experimental procedures, were explained by __________________________. Information was given about all benefits, risks, inconveniences, or discomforts that might be expected. Specifically, participation in this study poses no known risks or hazards.

The opportunity to ask questions regarding the research and procedures was given. Participation in the project is completely voluntary, and participants may withdraw at any time without penalty, prejudice, or loss of benefits. All personal information is strictly confidential, and no names will be disclosed. Any new information that develops during the project will be provided if that information may affect the willingness to continue participation in the project.

Any questions or concerns about rights as a research participant should be directed to the Chair of the Institutional Review Board, The University of Southern Mississippi, 118 College Drive #5147, Hattiesburg, MS 39406-0001, (601) 266-6820. Additionally, any questions about the research should be directed to the University of Louisiana at Lafayette, P.O. Box 43170, Lafayette, Louisiana 70504; Dr. Nicole Muller (IRB Chair), (337) 482-6489 and/or Sidney Mitchell at (337) 241-4065. Participants will be given a copy of the consent documentation for their records.

____ ____________________
Signature of participant Date

____ ____________________
Signature of person explaining the study Date

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