Exploring the Effects of Program Development:

A Comparison of the Academic Achievement, University Retention, and STEM Retention of Learning Community Cohorts

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Abstract

The national movement to increase the number of graduates with science, technology, engineering, and math (STEM) majors has placed pressure on undergraduate institutions to graduate 34% more STEM students each year. There is also tremendous pressure to retain women and racial/ethnic minorities in STEM majors given they are disproportionately underrepresented in the STEM workforce. In response to national pressure, universities have developed a range of retention programs aiming to support these underrepresented groups. Yet little research has examined whether the programs are associated with positive outcomes, including academic achievement, first-year university retention, and STEM retention. The Achievement In Math and Science (AIMS) learning community at Rutgers University provided a variety of academic interventions to four cohorts of students across four years. As the program developed, recruitment practices were modified, program elements were enhanced, and additional interventions were implemented yearly. This study examined whether the academic achievement, university retention, and STEM retention of successive cohorts improved across program years as the program was enhanced. The statistical analyses demonstrated that cohort was predictive of STEM retention, but not associated with academic achievement or predictive of university retention. This suggests that later program cohorts were more likely to be retained in STEM. Other noteworthy findings indicated that higher math placements were associated with increased academic success, but did not affect the grade point averages (GPAs) of later cohorts, females, and minorities. Additionally, gender was found to be predictive of first-year university retention with females more likely to be retained by the university during their first and second years. This is the first study to analyze different cohorts of the same program while focusing on first-year outcomes and STEM retention. These findings suggest that women and underrepresented minorities, controlling for cohort year, math placement, gender, and ethnicity, can experience academic success and retention rates equal to their peers. The findings identified from this study offer implications for the development of first-year programs that lead to improved retention and academic performance for women and minority groups enrolled in STEM disciplines at the undergraduate level. Namely, early intervention, academic and social integration, and academic skill-building may be essential to the retention of students in the STEM pipeline bringing diverse learners into the STEM workforce.

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Introduction

As one generation of professionals in the work force approaches retirement another generation is acquiring the literacy and skills to fill their positions. This natural progression and transition of the labor force faces an economic problem when a generation retires and there is a lack of interested, educated, and skilled individuals to replace them. This is currently the alarming situation faced by STEM fields across the United States. The steady decline of student interest in STEM fields in recent decades has proven to be a national crisis due to a projected increase in STEM jobs and the approaching retirement of current STEM professionals (National Science Board, 2003). Globally, the United States is no longer spearheading technological development and advancement and as a nation, we no longer have the ability to meet indigenous needs, outsourcing to other countries (National Intelligence Council, 2008). According to the President's Council of Advisors on Science and Technology (2012), the nation must graduate one million more STEM students in the next decade, an additional 34% annually, to meet the needs of economic projections.

The responsibility of the country's economic well being has fallen on colleges and universities across the nation, who are now faced with the challenge of recruiting, retaining and graduating an increased number of students with strong STEM skills, literacy, and training. In addition to the expected quantity of STEM students they are expected to prepare, institutions are also faced with the task of remediation due to the quality of education of incoming students (The National Commission on Excellence in Education, 1983). As institutions of higher learning work towards overcoming the challenges set before them, it is critical that they identify the institutional factors and program elements highly correlated with student progress in pursuing STEM degrees (Johnson, 2012). With the identification of these academic elements comes the potential for targeted interventions. The problem faced by the nation is multifaceted and so the approach must be the same.

The purpose of the current study was to examine the academic achievement, first-year university retention, and STEM retention of the Rutgers University – Science Talent Expansion Program (RU-STEP) AIMS learning community cohorts that experienced different recruitment and academic interventions. An additional goal was to identify specific program elements that might be useful in developing targeted first-year programs that lead to improvement of early student success and retention for future STEM majors.

Women and Underrepresented Minorities

The United States has an increasingly diverse population predominantly comprised of young women and minority youth (Jackson, 2006). Unfortunately, these underrepresented groups are disproportionately represented in undergraduate STEM enrollment and graduation rates (Chubin & Malcolm, 2006). Upon examining the gaps related to gender, race, and ethnicity, the U.S. Department of Education (2000), concluded that relative to men and whites, women and minorities, with the exception of Asian Americans, were significantly underrepresented in the admissions, persistence, and attainment of undergraduate STEM degrees. According to the National Center for Educational Statistics (2009) students entering college from high school increased from 50% to 66% from 1980 to 1998, however the rates for minority students only increased from 16.5% to 26.6% indicating they are not only underrepresented but also increasing at lower rates. Women and minorities make up 70% of the undergraduate population, but only 45% of those earning undergraduate STEM degrees (The President's Council of Advisors on Science and Technology, 2012). They represent a significant proportion of the prospective workforce, therefore the disparity within STEM fields indicate they are an untapped source of talent in need of recruitment (Reid, 2009).

Despite the conscientious efforts to recruit and retain these groups, data indicates that they continue to be significantly under-represented in STEM disciplines as the shortage of STEM professionals continues to rise (Reid, 2009). It is evident that the future of America's STEM workforce is in jeopardy and the national commitment to the intellectual development of all youth is essential to address attrition, retention, and persistence in STEM disciplines. Additionally, the disproportionate representation of women and minorities in STEM fields indicate the need for further investigation and facilitation of experiences that would develop interest and skill to encourage persistence within these groups (Reid, 2009).

STEM Attrition & Retention

Attrition. The "science pipeline" is a metaphor often used to refer to the path from the beginning of secondary school, through college, and to career entry in any STEM discipline (Blickenstaff, 2005). The pipeline has been notorious for being particularly leaky and containing filters with respect to certain genders, races, and ethnicities. Students, regardless of gender, race, and ethnicity enter the pipeline, however women and under-represented minorities leave more frequently at various junctures along the way. In 2001, 94.8% of Asians and 86.7% of Caucasian students pursuing STEM degrees completed their degree in comparison to 62.5% of African Americans (Anderson & Kim, 2006). In 2005, American and Canadian statistics found that 30% to 40% of college students enrolled in STEM programs did not finish their degree in a science major (Ratelle, Larose, Guay, & Senecal, 2005). A 2010 study indicated that the attrition rates of U.S. college students with a declared STEM major increased to 50% and the rates for women and minorities were even higher (Lowery, 2010). These daunting statistics have encouraged researchers to work towards identifying the most leaky areas of the STEM pipeline.

Extensive research has been conducted to examine the lack of representation of women and minorities within STEM disciplines and the factors contributing to their departure from the field across the pipeline (Arch, 1995; Civian & Schley, 1996; National Research Council, 1991; National Science Foundation, 2000; Rayman & Brett, 1993; Seymour, 1992, 1995a; Wood & Schaer, 1991). These groups are exposed to a variety of segregating experiences while pursuing STEM degrees. Although the findings vary, they include environmental and social-cognitive factors that speak to issues specific to women and minorities. Environmental contributors include the lack of a supportive environment and role models (Fear-Fenn & Kapostasy, 1992), stereotypic images and expectations of gender roles (U. S. Department of Education/NCES, 2000), financial pressures (Johnson, 2012), peer-pressure, the learning environment (American Association of University Women, 1995), and instructor behavior (Matyas, 1992). Faculty related issues like poor teaching skills, lack of approachability, help, and advice, accelerated pace of instruction as well as institutional factors like course workload and the time required to complete degree requirements also influenced student decisions to leave STEM (Seymour, 1992). Internal factors impacting their decision included their perception of STEM relevance (Fear-Fenn & Kapostasy, 1992) and low self-confidence (Seymour & Hewitt, 1997; Ware & Lee, 1988).

The academic culture of STEM disciplines is often discriminatory toward women, disregarding the environment from which they may come as well as the biological and norm differences between the genders (Betz, 2002). Additional factors contribute to their STEM attrition. There are distinguishing experiences of minorities and women from their white male peers, but one study showed that women, in particular, (a) interpreted the initial "weed-out system" differently from their male counterparts by placing personal significance on individual failure rather than group ability (b) found themselves in a traditionally male social system, (c) were required to adjust to a system intended to support white males, (d) continuously felt the need to demonstrate their abilities through competition, (e) had a high desire for praise, and (f) found the form of socialization required to interact within the academic atmosphere to be incompatible with their own experiences and expectations (Seymour, 1995a). Another study showed that women were also found to leave the sciences due to family issues, lack of opportunity, male dominance, and stress (Cronin & Roger, 1999). The literature identifies three distinct junctures at which females exit the pipeline: (1) during the initial career choice, (2) the transition from undergraduate to the graduate degree, and (3) career entry into academia (Betz, 2002).

Civian and Schley (1996) conducted a study at Wellesley College in Massachusetts, following 445 female students from orientation to graduation to identify factors associated with persistence in math and science. The college was culturally receptive with adequate female faculty intended to support women academically. Results from quantitative and qualitative data indicated the decision to leave was influenced by the time involved in pursuing the degree, the difficulty and workload of the courses, and the development of interest in other fields. The findings suggest that women who are provided with gender specific academic support continue to leave STEM for reasons similar to their minority counterparts.

A study conducted to explore the reasons undergraduate students were leaving health science programs before program completion identified five contributing factors; (1) the wrong career choice, (2) inability to see career pathways, (3) lack of support or connection with faculty,

(4) inadequate academic preparation for the demands of university work, and (5) stress (Gillis, 2007). Their findings suggest attrition can be addressed and prevented with the appropriate preparation and evidence based interventions to alleviate the effects of the contributing factors. With the identification of specific pipeline leaks, the attention has been shifted to focus on fixing the pipeline before the leakage occurs (Reid, 2009).

Retention. Retention, as it relates to students attending an institution of higher learning, is defined as the continuous enrollment through the completion of their academic program (Seidman 2005; Taylor & Miller, 2002). University retention rates are the leading and most widely used predictor of institutional success and student satisfaction (Levitz, Noel, & Richter, 1999).

Comparable to attrition, retention factors have been an area of interest for many researchers, educators, and economists. Vincent Tinto’s retention model (Tinto, 1975, 1997) indicates that there are internal and external factors that have been found to impact student retention in the first year. Bonous-Hammarth (2000) investigated the attrition and retention of minorities within STEM disciplines and findings consisted of several prominent components. Students experienced the most success with consistent and effective motivation, academic engagement programming, ample academic preparation ensuring competency, positive interactions with STEM peers and key faculty, and involvement in clubs and industry sponsored organizations (Bonous-Hammarth, 2000; Johnson, 2012). In addition, attending to the psychosocial needs of under-represented students in an academic atmosphere positively contributed to increased student success (Reid, 2009). Supportive and nurturing role models were found to affect the long-term academic persistence of women in science (Bonous-Hammarth, 2000). Women and minority students have been and continue to be intentionally recruited into the STEM pipeline, but they require continuous academic support and encouragement to prevent them from "leaking out" (Mau, 2003). Despite intentional retention strategies, the national rate for minority students continues to be lower than that of Caucasian students (McClanahan, 2004).

Declining undergraduate retention rates are affecting the enrollment of students in STEM graduate programs. National data has indicated that more than half of all students who express interest in a STEM discipline going into their undergraduate career do not graduate with a STEM degree (Higher Education Research Institute, 2010) and more than half of those who graduate with a STEM degree switch to a non-STEM field when entering a graduate program or the job market (National Science Board, 2012). The lack of graduate students contributes to the shortage of leading STEM professionals, further exacerbating the economic situation. The improvement of undergraduate retention rates is the first step to counteracting this chain reaction. According to Ronald Ehrenberg, the Irving M. Ives Professor of Industrial and Labor Relations and Economics at Cornell and the director of the Cornell Higher Education Research Institute (CHERI), the most efficient way to increase STEM professionals is to reduce the dropout rate from undergraduate STEM majors (Johnson, 2012). The "All STEM for Some" framework proposes the recruitment of the most interested and capable students, who are then provided with the academic resources and educational experiences necessary to make it through the pipeline and earn an advanced STEM degree, thus guaranteeing their ability to contribute to the nation's innovative and economic growth (Atkinson & Mayo, 2010). This approach however, is highly dependent upon the individual student's level of interest and academic proficiency as well as the institution's ability to provide the necessary components of a STEM environment and culture in which the student can succeed (Reid, 2009). For the purposes of this study, university retention will refer to continuous enrollment from freshman to sophomore year at Rutgers University and STEM retention will refer to the declaration of a major in a STEM discipline.

Interventions and Retention Programs

The research on the recruitment, attrition, and retention of women and underrepresented minority groups in STEM has resulted in the development of varying interventions and programming designed to encourage and support their participation and performance in STEM education and careers. The literature has identified an array of individual characteristics, traits, and factors that contribute to their perceptions, experiences, and decisions. However, there is significantly less research examining the relationship between retention and institutional behavior, rather than retention and individual student variables (Gansemer-Topf & Schuh, 2006).

Tinto's 2012 presentation "Promoting Student Completion One Class at a Time," advocated a shift from a teaching paradigm to a learning paradigm. He proposed that educators concentrate on the conditions in which they place students by providing them with strategies proven to promote academic success. There is a need for institutions to actively generate positive experiences and environments for the minority students on their campus (Eimers, 2001). A large percentage of first-year students are not equipped with the academic skills to succeed given the increased workload and complexity of material and assignments (Marshall, 2010). Rather than view this problem as a manifestation of the student's limitations, the learning paradigm or institutional behavior approach accommodates the student by fostering an intervention to support them in their area(s) of weakness. The primary goal of targeted first-year programs and interventions is to mitigate the obstacles students face in their first year by providing them with the academic support they require to avoid premature failure and ensure success (Morley 2003-2004; Sorrentino, 2006).

The National Science Foundation (NSF) has been a driving force on the forefront of the STEM recruitment and retention efforts. The NSF continues to fund and support programs that generate student interest in STEM, train them in STEM disciplines, and promote career development in those fields (Wiedenbeck & Scholtz, 1995). The NSF is particularly interested in increasing the disproportionate representation of women and minority groups pursuing STEM, recognizing that they have academic and social integration needs most traditional universities are not fully equipped to address (Arbona & Nora, 2007; Simpson, 2001; Walker & Satterwhite, 2002).

The research shows that academic support programs contribute significantly to the successful integration of students of color (Good, Halpin & Halpin, 2002; Jackson, Smith & Hall, 2003). Social integration through quality faculty and peer interaction is highly influential on the experiences of undergraduate students and has proven to be a significant factor in predicting retention (Pascarella & Terenzini, 2005; Fries- Britt & Turner, 2002; Gloria & Ho, 2003; Gloria, Castellanos, Lopez & Rosales, 2005). Faculty mentoring allows students to develop stronger connections with academic departments (Littleton, 2003; Reason, 2003; Santos & Reigadas, 2004). Peer mentoring programs contribute to academic persistence by providing learning communities with integrated support systems and resourceful peer networks (Russomano, Best, Ivey, Haddock, Franceschetti, & Hairston 2010). Peer tutoring has proven to be academically effective for both students involved (Chi, Silver, Jeong, Yamauchi, & Hausmann, 2001; Cohen, Kulik, & Kulik, 1982). Bridge programs and research experiences have been found to contribute to raising the graduation rates among minority students pursuing STEM majors (Koenig, 2009; Yelamarthi & Mawasha, 2008). The RU-STEPed Up for Success AIMS

Program under investigation in the present study is designed to facilitate the academic and social integration of its participants through the use of these evidence-based strategies.

Institutions, like Rutgers University (RU), with specific missions that target the education of STEM professionals are expected to contribute to the solution of this wide spread problem. RU, as one of the leading scientific research universities in North America, whose graduates focus on STEM disciplines, will serve as the focus of this research. Rutgers University is a large public institution with over 65,000 students and100 undergraduate majors where almost one-third of students reside on campus in one of their 58 residence halls. Despite its breadth, the university is comprised of smaller campuses, which are further separated into schools and colleges with academic programs nested within to create a sense of community among students, faculty, and staff.

The commitment to retaining women and underrepresented minorities in STEM disciplines involves the investigation of factors that might contribute to increased retention of these groups. The challenge arises in developing learning environments, implementing intervention programs, and creating a welcoming institutional culture that integrates these factors. Understanding the student outcomes of the AIMS participants in the RU-STEPed Up for Success Program should: 1) assist with providing and improving retention programs and services; 2) help the university better utilize available resources; and 3) provide improved education for underrepresented students. Despite the recent efforts, studies have failed to focus on early academic achievement and retention as well as STEM retention controlling for cohort, math placement, gender, and ethnicity. In addition, there has been no attempt to investigate these factors among participants of the same program. The current study will contribute to the understanding of the retention of women and underrepresented minority groups in STEM disciplines, with respect to recruitment, interventions, and their involvement in the RU-STEPed for Success AIMS Program. Program success was determined by improved student outcomes across cohorts as the program grew and developed specifically in the areas of academic achievement measured by GPA, continued enrollment at Rutgers University, and retention in a STEM discipline.

The Rutgers University, Student Talent Expansion Program (RU-STEP) Achievement in Math and Science (AIMS) Learning Communities

Rutgers University (RU). Rutgers University (RU) is located in New Jersey and is made up of three major campuses; Rutgers – New Brunswick, which is comprised of five smaller campuses with eight undergraduate schools, Rutgers – Newark with 10 undergraduate schools, and Rutgers – Camden with four undergraduate schools. There are 33 schools and colleges with more than 100 undergraduate majors and more than 200 graduate majors. The university has a strong commitment to diversity evident in its undergraduate population. Eighty-six percent of all students are New Jersey residents, 47% are male and 53% are female, and more than 80% of students receive financial aid. According to the Institutional Profile Report of 2013, there were 43,967 undergraduates enrolled at Rutgers University with 6.2% (2,735) enrolled in remedial courses. However, only 7,698 students were first-time, full-time (FTFT) students and of those 24.1% (1,855) were enrolled in remedial classes (Rutgers, 2014c).

RU is a renowned institution of higher learning recognized for the quality and scope of their research and educational programs. The institution is a member of the Association of American Universities (AAU), a group comprising North America's 62 leading research universities. The university recently became a member of the Committee on Institutional Cooperation (CIC), a consortium of first-tier research universities that share knowledge and best practices to strengthen higher education and support research endeavors. CIC universities conduct billions of dollars in funded research every year (Rutgers, 2014d).

As a public research university in New Jersey the university's mission is threefold: (1) to provide for the instruction needs of New Jersey's citizens through undergraduate, graduate, and continuing education program, (2) to conduct cutting-edge research thus contributing to the medical, environmental, social and cultural well-being of the state and economy, and (3) to provide public service in support of the needs of the state and its citizens. The Office of Undergraduate Education was created to improve academic and co-curricular aspects of the undergraduate experience. Three divisions were created within undergraduate education: instructional support, academic enrichment and programming, and undergraduate academic affairs, which encouraged the cultivation of the RU-STEPed Up for Success program and its intentional programming for STEM retention (Rutgers, 2014a).

Rutgers University - Science Talent Expansion Program (RU-STEP). The Rutgers University Science Talent Expansion Program (RU-STEP) is described as a "cohesive set of programmatic interventions that address strategic points in the continuum of undergraduate education" (AIMS Program Grant, 2008). The overall program goal is to increase the number of students who graduate with STEM majors. It was designed to preferentially recruit and retain underrepresented and minority students in science, technology, and mathematics (STEM) disciplines because these groups compose a critical proportion of the workforce however they are disproportionately unrepresented within STEM fields. Engineering students were excluded from the first-year learning communities because they are already housed together and take the same courses. RU-STEP is a first-year and transfer program, comprised of learning communities, that focuses on providing academic resources and support to these underrepresented groups so they may be successfully retained during their first year at the university. Retention efforts target academic areas specific to STEM persistence like remedial math for basic skills proficiency and introductory STEM courses with high rates of failure. The program planned to improve first-year retention rates by increasing competence in writing, mathematics, and chemistry, addressing problems specific to transfer students and women in STEM, and increasing the awareness of possible career options in STEM.

Achievement in Math and Science (AIMS) Learning Communities. The Achievement in Math and Science (AIMS) Learning Communities are part of the RU-STEPed Up For Success National Science Foundation (NSF) Program. Funded in 2008 through the NSF, the AIMS learning communities, intended to specifically recruit and retain a more diverse population of STEM students. The AIMS program was offered as a living-learning or commuter program. The learning communities were created with the following goals in mind: (1) to increase the number of underrepresented groups entering the STEM disciplines, particularly underrepresented minorities across the STEM disciplines and (2) to improve the retention rates of students in STEM disciplines by increasing writing, mathematics, and chemistry competence and by increasing students knowledge about possible career options. A table of recruitment and intervention changes by cohort can be found in Appendix C and a comprehensive description of each program element as well as detailed program changes by cohort can be found in Appendix E.

Summary

In summary, the declining interest in STEM has been a cause for national concern as it has impacted the nation’s technological advancement as well as its ability to meet indigenous needs (National Intelligence Council, 2008). Women and underrepresented minorities make up a significant proportion of the population but their undergraduate STEM retention rates and representation in STEM fields are significantly lower than their male and non-minority peers (Jackson, 2006; Chubin & Malcolm, 2006; U.S. Department of Education, 2000). Retention programs have been developed at colleges and universities across the nation in an effort to recruit and retain these groups at greater rates. Prior studies (Arch, 1995; Civian & Schley, 1996; NRC, 1991; NSF, 2000; Rayman & Brett, 1995; Seymour, 1992, 1995a; Wood & Schaer, 1991) have examined the factors contributing to the attrition of women and minorities in STEM, but there are still many gaps in the literature. There is still a need to evaluate existing programs, such as the RU-STEPed Up for Success AIMS Program, to determine the impact of early intervention and predictor variables on first-year academic achievement and university retention as well as STEM retention. The present study builds upon existing literature to achieve this goal and is unique in its attempt to investigate the difference between cohorts of the same program.

The findings identified from this study will be useful in developing targeted first-year programs that lead to improved early student success and retention for future STEM majors. More specifically findings may lead to changes in recruitment practices, restructuring of curriculum, an emphasis or de-emphasis on living-learning communities, and/or adjustments to social programming for students pursuing STEM disciplines. In addition, the research conducted will provide RU with the information to improve the existing resources and further increase the retention rates of women and underrepresented minority students. The diminishing representation of these groups is nationally concerning as it has negatively influenced our nation's global leadership. Our increased efforts to better understand their persistent underrepresentation may lead to tangible points of intervention.

The study is important because the core elements of the program, as per the findings, can be replicated and mainstreamed at RU and potentially by similar institutions throughout the United States in an effort to provide future STEM students with an evidence-based first-year retention program.

Hypotheses

Hypothesis 1: It was hypothesized that there would be higher academic achievement in later cohorts as the program became more multi-faceted over the years.

Hypothesis 2 and 3: It was also hypothesized that later cohorts would have higher rates of (2) university and (3) STEM retention than earlier cohorts.

During each year of the program, modifications were made to recruitment, available resources were enhanced, and academic support was increased. Recruitment was changed to encourage applicants with a strong desire and commitment to STEM. Additional resources provided participants with academic, social, and professional support enabling them to fully integrate into their environment. These interventions were also meant to compensate for academic and socioeconomic disadvantages that may exist to ensure early academic success leading to STEM retention. The null hypothesis is that there will be no significant outcome differences (i.e. academic achievement, university retention, and STEM retention) between the four participating cohorts.

Methods

The purpose of this study was to determine whether cohort year was predictive of academic achievement and retention rates for participating Achievement In Math and Science (AIMS) learning community students in the School of Arts and Sciences (SAS) and the School of Environmental and Biological Sciences (SEBS) at Rutgers University. The program developed over time with changes in recruitment practices and implementation of additional interventions, therefore each entering cohort's experience was unique. Prior studies suggest that the recruitment of students with higher levels of interest and provision of increased academic support during the first year positively contributes to academic achievement and student retention in science, technology, and math (STEM) disciplines (Reid, 2009; Atkinson & Mayo, 2010). The AIMS program was designed to recruit and increase the retention of women and underrepresented minority groups in STEM fields.

In this chapter the research methods employed in this study are described. The research questions, sample participants selected for the study, and the methods used to collect as well as analyze the data are discussed. This chapter is organized into the following sections: (a) research questions, (b) participants, (c) procedures, (d) measures, (e) independent variables, (e) dependent variables, and (f) data analysis plan. The outcome data used in this study came from existing data sources collected from fall 2008 through spring 2013 through the Student Records Data Base (SRDB) and the Principal Investigator, Dr. Kathleen Scott at Rutgers University. The data was then analyzed retrospectively in aggregate during summer 2014.

Research Questions

The following research questions were investigated in this study: Was there a significant difference in the (1) academic achievement as measured by GPA, (2) university retention from freshman to sophomore year, (3) and STEM retention of successively participating cohorts of AIMS students?

Participants

Participants in the present study were limited to first-year students enrolled in the School of Arts and Sciences (SAS) and School of Environmental and Biological Sciences (SEBS) on the New Brunswick campus of Rutgers University. All students participated in the Achievement in Math and Science (AIMS) Learning Communities during their first year of undergraduate school. The study involved four successive cohorts, the graduating class of 2012 (n = 71), 2013 (n = 109), 2014 (n = 88), and 2015 (n = 90). There were 358 students in all four cohorts comprised of both residential (77%) and commuter (23%) students.

During the first year, there were three communities: the living- learning community was located on one floor in Davidson Hall on the Busch Campus, the learning community commuter program was located on the Busch Campus, and the multi-campus commuter community was spread across the New Brunswick campuses. In the years following, the living-learning community on the Busch Campus was moved from Davidson Hall to Metzger Hall where it remained for the duration of the program. An additional living-learning community was added in Perry Hall on the Cook Campus. The location of the residential communities impacted student decisions, specifically those with a preference for a specific campus or residence hall. The Commuter program remained on the Busch Campus and the multi-campus commuter community was discontinued. The first cohort was recruited during summer 2008 and entered in fall 2008. The 2013, 2014, and 2015 cohorts were recruited during the spring and summer months and entered in fall 2009, 2010, and 2011, respectively.

Inclusion and Exclusion Criteria. All students who participated in the study were registered in either SAS or SEBS and indicated an interest in a major course of study in science, math, or technology. Engineering students were excluded because they have their own learning community at RU. Students were recruited based on their placement into basic-skills courses, gender, and ethnicity.

Participants were required to have math placement scores at the Elementary Algebra, Intermediate Algebra, or Pre-Calculus level. All participants placed into one of the following math placements: Algebra (27%), Pre-Calculus (71%), and Calculus (2%). Algebra included Elementary Algebra 025 (n = 3) and Intermediate Algebra 026 (n = 95). STEM students with this placement took either Math 025 or 026 in their first semester while Pre-Calculus students (n = 253) took either Math 111 or 115. Calculus students (n = 7) were scheduled to take either Math 135 or 151, however due to the small number of Calculus placements they were coded as Pre-Calculus. Students who placed into Algebra were coded 1 while students who placed into Pre-Calculus and Calculus were coded 2.

Students were further selected by gender and ethnicity, specifically recruiting women and underrepresented minorities. All females were invited to participate regardless of race/ethnicity, while only minority males were extended an invitation. White and Asian males were originally deemed ineligible based on ample representation in STEM fields and were to be excluded from participation, however due to the availability of spaces they were later invited to participate. The demographic information collected indicated 255 female (71%) and 103 male (29%) participants. Whites and Asians (57.8%) were coded as non-minority while all others (42%) were coded as minority. Table 1 contains a summary of participant demographics by cohort, gender and ethnicity.

Table 1

Summary of Participant Demographics by Cohort, Gender, & Ethnicity

Cohort		Black	Hispanic	Puerto Rican	White	Asian	Pacific Islander	Multi-Racial	Undisclosed
2012	Males	2	2	0	0	1	0	2	
	Females	11	9	3	21	18	1	1	
2013	Males	4	3	1	16	7	2	4	1
	Females	15	1	2	33	16	1	3	
2014	Males	2	6	2	7	10		2	
	Females	20	5	3	17	13	1		
2015	Males	7	5	1	7	6	1	2	
	Females	15	5	2	22	13		2	2
Total		76	36	14	123	84	6	16	3

Students were recruited based on the aforementioned criteria and participation was through invitation only. Invitations were sent to eligible candidates via e-mail and invited students self-selected into the program.

Procedures

Prior to program enrollment, all eligible students were informed of the academic benefits as well as the mandatory class scheduling associated with the AIMS learning communities. All students who self-selected into the program participated in the study. All participants were exposed to students of similar academic interests, provided with academic success workshops and academic advising sessions each semester with their respective dean, and assigned to a specific section of the First-Year Interest Group Seminar (FIGS), which explored careers in the sciences. Commuter students were assigned to an AIMS commuter peer mentor. Residential students were guaranteed housing in Metzger Hall on the Busch Campus or Perry Hall on the Cook Campus with fellow AIMS students and live-in peer mentors, with the exception of the first-year, 2008, when the Busch Campus living-learning community was located in Davidson Hall and there was no Perry Hall community or live-in peer mentors. In-residence tutoring for math, chemistry, and writing were also provided and open to both commuter and residential students. Despite exposure and access to the interventions and resources it was ultimately the student's responsibility to utilize them.

This study was conducted in accordance with the Social and Behavioral Institutional Review Board (IRB), protocol E15-014. All of the data used in this study was carefully protected for confidentiality by the researcher. There have not been any reported instances of physical, emotional, or other types of harm to participants in the studies reported in the literature using these procedures.

Measures

AIMS Program Participation Eligibility. University records provided by the first-year deans' offices of SAS and SEBS were examined to determine school, gender, race/ethnicity, math placement results, and intended major. For a full list of eligible STEM majors see Appendix B.

Independent Variables. The independent or predictor variables for this study were cohort, gender, ethnicity and the covariate math placement. The purpose of this study was to determine whether improvement occurred throughout the course of the overall program therefore individual program changes and interventions were not coded and analyzed. The study did not correlate findings with specific interventions, but to the program as it was implemented each year. Please see Appendix C for a list of recruitment and intervention changes by academic entrance year.

Dependent Variables. The dependent variables for this study were academic achievement, university retention, and STEM retention.

Academic Achievement. The student data pertaining to academic achievement was collected from the SRDB. The measure used to determine academic success was the student's cumulative grade point average (GPA) at the end of the first year of enrollment. GPAs in the data set were calculated on a 4-point scale using the student's course grades. Each possible letter grade was assigned to a specific number of points and included: A (4), B+ (3.5), B (3), C+ (2.5), C (2), D (1), and F (0). Individual class grade points were then multiplied by the number of course credits earned. The final GPA was calculated by dividing the total amount of grade points earned by the total amount of credit hours attempted ranging from 0.0 to 4.0 (Rutgers, 2014b).

University Retention. University retention was defined as student retention from freshman to sophomore year. Data from the SRDB was used to determine university retention by examining the third semester of enrollment. If the student was not enrolled during the fall semester of their second year their retention was coded as 0. Students who were enrolled received a retention code of 1. For the purposes of this study, students enrolled in any school within the university were considered retained.

STEM Retention. Data from the SRDB was used to determine STEM retention in the student's fifth semester of enrollment. STEM retention was determined by major declaration. University retention indicated that the student was successfully retained past their first year, but does not indicate they have been retained in a STEM major. Students retained past their third semester to STEM declaration in their fifth semester indicate lasting effects. Students in the School of Arts and Sciences (SAS) are required to declare a major by the time they have acquired 60 credits therefore they typically declare their major in the second semester of their sophomore year. However some majors require students to declare earlier than others to allow for the completion of the required course sequence within four years. Students in the School of Environmental and Biological Sciences (SEBS) typically declare their major by the spring semester of their first-year. Majors are not coded until students formally declare a major therefore, STEM retention was measured by major declaration during the student's fifth semester. Students majoring in one of the targeted STEM majors found in Appendix B were coded as 1 and all other majors were coded as 0. Undeclared students (n = 111) were coded based on the presence or absence of one or more STEM courses in their fifth semester schedule. Students enrolled in STEM classes during their fifth semester were continuing on the academic STEM path and were coded as a STEM major. Alternatively, students who were not enrolled in STEM classes during their fifth semester were coded as a non-STEM major.

Please see Appendix D for the codebook containing a full list of study variables and how they were coded.

Missing Data

The variables were analyzed for missing data and a vast majority of data was not missing. Three individuals were not included in any of the analyses due to undisclosed ethnicity.

Academic achievement was measured as the cumulative grade point average (GPA) for the fall and spring semesters of their first undergraduate year. This information was missing for nine students indicating they left between the fall and spring semester of their first year. The missing data was not included in the multi-factor ANOVA analyses. However, two students, present for both semesters of their first year, earned a cumulative GPA of 0.00, therefore their GPAs were included in the analyses.

University retention was measured in the third semester of attendance. There were six students who were not retained in the third semester, but later returned to the university and were retained in STEM. Despite their return they were coded as not retained for university retention because they were not enrolled with their cohort at the time data was collected, however they were coded as retained in STEM.

STEM Retention was measured in the students' fifth semester of attendance. Undeclared students were considered retained if they were registered for two or more STEM classes. Eligible STEM classes were defined as any class falling under one of the listed STEM major departments in Appendix B.

Data Analysis Plan

All data collected for this study was entered into the Statistical Package for the Social Sciences for Windows (SPSS). The statistical analyses were based on the independent and dependent variables driving the research questions. The alpha level of .05 was used as the level of significance to determine whether to reject or accept the null hypothesis. Type I error was limited by this conventional alpha value to assure that a significant relationship was not found where one does not exist. Descriptive statistics were examined using means, ranges, and standard deviations. Gender (male, female), ethnicity (non-minority, minority), and math placement (algebra, pre-calculus) were coded dichotomously (1, 2) while cohort (graduating year of 2012, 2013, 2014, and 2015) was treated as a categorical variable, coded from 1 to 4.

Academic Achievement. A multi-factor analysis of variance (ANOVA) was used to analyze academic achievement, measured by GPA, as the continuous dependent variable with cohort, math placement, gender, and ethnicity as categorical independent variables.

Due to the nature of the study, the participants were not randomly assigned to the different intervention conditions and pre-existing cohorts were utilized. Consequently, the initial differences between the cohorts on pre-admission characteristics can not be attributed to chance or the inability to select subjects at random (Tabachnick & Fidell, 2007). More importantly, these initial differences could confound the relationship under study. Therefore, a statistical control was employed to extract the effects of math placement and reduce the bias from this particular academic characteristic, which represented their level of math skills prior to their enrollment in the program. Math placement is a particularly important variable as it has been shown to affect STEM success (Thiel, Peterman, & Brown, 2008). The multi-factor ANOVA examined the differences in main effects and identified any interaction effects.

A post-hoc Tukey analysis was not necessary to identify the significant differences between the cohorts and their academic achievement. A simple interaction effects analysis was conducted to examine the significant three-way interaction. Simple effects were then analyzed for all of the two-way interactions by using the general linear model in combination with the COMPARE subcommands in the SPSS syntax (Howell & Lacroix, 2012).

University and STEM Retention. A hierarchical logistic regression analysis was conducted to examine the relationship between the independent variables and the dichotomous dependent variables after controlling for the effects of a separate independent variable. More specifically, this analysis determined whether cohort, gender, and ethnicity, controlling for math placement, was predictive of university and STEM retention. The independent variables were consecutively entered in two stages to allow for a hierarchical logistic regression. In the first stage, or block, the control variable was entered into the regression. It was important to take this factor into consideration as a covariate to determine whether significant differences could be attributed to pre-admission characteristics like math skills or to the independent variables of interest. In the second stage, or block, the independent variables were entered and then simultaneously added to the model. The second block included the following independent variables: cohort, gender, and ethnicity.

Prior to running the full model, primary data analysis involved examining descriptive statistics to assess for violated assumptions. Descriptive statistics are reported. Although logistic regression does not have all of the restrictive assumptions that pertain to other analyses, the applicable assumptions were considered and found to be adequately met. The major assumption for logistic regression is that the outcome variable is discreet and dichotomous in nature. Retention is a dichotomous variable, which satisfies the level of measurement requirement for the dependent variable.

Logistic regression analyses require larger sample sizes to provide sufficient records for all categories of the response variables. In addition, the more independent or explanatory variables present, the larger the sample size required. As the sample size increases in a logistic regression the standard error decreases. Although sample sizes larger than 400 are recommended (Hosmer & Lemeshow, 2000), a rule of thumb for the preferred case to variable ratio for each possible independent combination is 20:1 (Miles & Shevlin, 2001). The present study contained 355 cases, with 1 control and 3 independent variables making the ratio of case to variable 88:1, much higher than the preferred ratio.

There are no assumptions regarding the distribution of the independent variables, however, it is required that they are not highly correlated with each other. After the full models were run for both university and STEM retention, the predictor variables were examined for multi-collinearity. Multi-collinear relationships were not found. Similarly, there is no support in the literature that the independent variables (cohort, gender, ethnicity, and math placement) are highly correlated with each other.

Role of the Researcher

This researcher served as the Graduate Advisor for the AIMS learning communities during the 2010-2011 and 2011-2012 academic years. She began in summer 2010 and continued through summer 2012.

Results

This study had three distinct quantitative components. The first was a multi-factor ANOVA measuring differences in academic achievement, while the second and third were logistic regression models predicting university and STEM retention, respectively. This chapter contains the analysis and findings from the study, which includes the descriptive statistics for the sample as well as the results section for each research question.

Descriptive Findings

Table 2 presented below provides the summary statistics for all categorical variables by cohort year. The table outlines the frequency and percentage of each categorical variable within the data set. The distribution trends remained consistent among the predictor variables. Minorities, females and pre-calculus students represented the majority consistently throughout the cohorts. Similarly, the majority of students were retained at the university with only a small percentage of attrition in each cohort. The trend for STEM retention shifted with more students majoring in non-STEM during the first year. During the following three years the majority of students were retained in STEM. Table 3 provides the descriptive statistics for academic achievement, the continuous dependent variable.

Table 2

Summary of Descriptive Statistics for Categorical Variables by Cohort

Variable		2012 Freq	2012 %	2013 Freq	2013 %	2014 Freq	2014 %	2015 Freq	2015 %	Total Freq	Total %
Ethnicity	Minority	31	43.7%	36	33.3%	41	46.6%	40	45.5%	148	41.7%
	Non-Minority	40	56.3%	72	66.7%	47	53.4%	48	54.5%	207	58.3%
Gender	Male	7	9.9%	38	34.9%	29	33%	29	32.2%	103	28.8%
	Female	64	90.1%	71	65.1%	59	67%	61	67.8%	255	71.2%
Math Placement	Algebra	28	39.4%	28	25.7%	24	27.3%	18	20%	98	27.4%
	Pre-Calculus	43	60.6%	81	74.3%	64	72.7%	72	80%	260	72.6%
University Retention	No	4	5.6%	9	8.3%	7	8%	2	2.2%	22	6.1%
	Yes	67	94.4%	100	91.7%	81	92%	88	97.8%	336	93.9%
STEM Retention	No	42	59.2%	42	38.5%	24	27.3%	25	27.8%	133	37.2%
	Yes	29	40.8%	67	61.5%	64	72.7%	65	72.2%	225	62.8%

Table 3

Summary of Descriptive Statistics for Academic Achievement

Variable	N	Mean	Median	Mode	Std. Dev.	Variance	Range	Min	Max
Academic Achievement	349	2.61	2.63	3.00	.65	.42	3.94	.00	3.94

The correlation coefficients for the predictor and outcome variables are provided in Table 4. Positive and negative correlations were not as expected. Academic achievement was significantly correlated with ethnicity ($r = .15, p < .01$) and gender ($r = .11, p < .05$), but not cohort ($r = .01$) and math placement ($r = .02$). Minorities and females had higher academic achievement than non-minorities and males. In contrast, STEM retention was significantly correlated with cohort ($r = .23, p < .01$) and math placement ($r = .15, p < .01$), but not ethnicity ($r = -.01$) and gender ($r = .02$). Later cohorts and students with higher math placements had greater rates of STEM retention. University retention was only significantly correlated to gender ($r = .15, p < .01$) indicating females had higher university retention than males. Interestingly, there were significant correlations between the outcome variables. Academic achievement was positively correlated with both university (r = .35, p < .01) and STEM retention (r = .26, p < .01). Students with higher academic achievement had greater rates of university and STEM retention. In addition, university retention was also positively correlated with STEM retention (r = .20, p < .01) indicating higher rates of first-year university retention were correlated with higher rates of STEM retention.

Table 4
Intercorrelation Between Student Demographics and Outcome Variables

	1	2	3	4	5	6	7
1. Cohort	-						
2. Ethnicity	.05	-					
3. Gender	-.13*	- .07	-				
4. Math Placement	.12*	-.10	-.08	-			
5. Academic Achievement	.01	.15**	.11*	.02	-		
6 University Retention	.07	-.02	.15**	.01	.35**	-	
7 STEM Retention	.23**	-.01	.02	.15**	.26**	.20**	-

* p < .05, ** p < .01

Academic Achievement

A multi-factor ANOVA was conducted to simultaneously test the main effects for each independent variable and to explore the possibility of interaction effects among the variables. This analysis explored the impact of math placement, cohort, gender, and ethnicity as categorizing independent variables on first-year academic achievement, the continuous dependent variable, as measured by GPA. A summary of the multi-factor ANOVA results can be found in Table 5.

Table 5

Summary of Multi-Factor ANOVA Results

Variable	Sum of squares	*df*	Mean square	*F*-value	*P*-value
Cohort	0.378	3	0.126	0.320	0.811
Ethnicity	2.624	1	2.624	6.654	0.010*
Gender	1.421	1	1.421	3.603	0.059
Math Placement	2.986	1	2.986	7.571	0.006*
Cohort x Ethnicity	1.182	3	0.394	0.999	0.393
Cohort x Gender	0.018	3	0.006	0.015	0.998
Cohort x Math Placement	4.393	3	1.464	3.713	0.012*
Ethnicity x Gender	0.224	1	0.224	0.567	0.452
Ethnicity x Math Placement	1.793	1	1.793	4.546	0.034*
Gender x Math Placement	2.676	1	2.676	6.784	0.010**
Cohort x Ethnicity x Gender	1.162	3	0.387	0.982	0.402
Cohort x Ethnicity x Math Placement	1.217	3	0.406	1.029	0.380
Cohort x Gender x Math Placement	5.528	3	1.843	4.672	0.003*
Ethnicity x Gender x Math Placement	0.631	1	0.631	1.599	0.207
Cohort x Ethnicity x Gender x Math Placement	0.091	2	0.045	0.115	0.891

* $p < .05$, ** $p < .01$

A statistically significant three-way interaction effect was found between cohort, gender, and math placement, F (3, 346) = 4.67, $p = .003$. This interaction indicates the presence of a two-way interaction that varies across levels of a third variable. Simple interaction effect analyses were conducted and identified three significant interactions and the levels at which they occurred (see Table 6).

First, the simple interaction of gender and math placement was significant for the 2012 cohort, F (3, 333) = 14.56, $p < .01$. Male pre-calculus students in the 2012 cohort had significantly higher academic achievement than male algebra students in the same cohort. In contrast, the female algebra students in that same cohort had significantly higher GPAs than the female pre-calculus students.

Second, the simple interaction of cohort and math placement was significant for male students $F\ (3, 333) = 4.48, p < .01$. Male students in the 2012 cohort, at the pre-calculus level, had significantly higher GPAs than males in the same cohort at the algebra level. In 2013, the academic achievement of the male pre-calculus students was lower whereas the GPAs of the male algebra students was higher and surpassed the pre-calculus students.

Lastly, the simple interaction effect of cohort and gender was significant at the pre-calculus level, $F\ (3, 333) = 5.71, p < .01$. Male students in the 2012 cohort, at the pre-calculus level, had significantly higher academic achievement than their female peers in the same cohort and math level. However, in 2013, female students at the pre-calculus level had significantly higher academic achievement than their male counterparts.

Table 6
Summary of Simple Interaction Effects Between Cohort, Gender, & Math Placement

Variable Level	Interaction	Sum of Squares	*df*	Mean Square	*F*-value	*P*-value
2012	Gender x Math Placement	5.82	1	5.823	14.78	.000*
2013	Gender x Math Placement	.299	1	.299	.76	.38
2014	Gender x Math Placement	.002	1	.002	.01	.94
2015	Gender x Math Placement	.248	1	.248	.63	.43
Male	Cohort x Math Placement	5.73	3	1.791	4.55	.004*
Female	Cohort x Math Placement	.719	3	.240	.61	.61
Algebra	Cohort x Gender	2.57	3	.856	2.17	.09
Pre-Calculus	Cohort x Gender	6.85	3	2.283	5.79	.000*

* p < .01

There were statistically significant two-way interaction effects between math placement and each of the other independent variables: cohort, $F\ (3, 346) = 3.71, p = .01$, gender, $F\ (1, 346) = 6.78, p = .01$, and ethnicity $F\ (1, 346) = 4.55, p = .03$. Simple main effects analyses showed that placement in a pre-calculus class led to higher academic achievement than placement in an algebra class for the 2012 cohort $F(1, 315) = 11.58$, $p = .001$, non-minorities $F(1, 315) = 8.07$, $p = .005$, and male students $F(1, 315) = 10.42$, $p = .001$ (see Table 7). For the 2013, 2014, and 2015 cohorts, minorities, and female students, math placement had no effect on academic achievement (see Figures 1, 2, & 3).

Table 7
Summary of Simple Effects for Two-Way Interactions

Variable		Mean Difference (I - J)**	*F*-value	*P*-value
Cohort	2012	- 0.981	11.577	0.001*
	2013	0.119	0.566	0.452
	2014	- 0.077	0.197	0.657
	2015	- 0.338	2.53	0.113
Ethnicity	Non-Minority	- 0.442	8.065	0.005*
	Minority	- 0.174	1.532	0.217
Gender	Male	- 0.629	10.419	0.001*
	Female	- 0.001	0.000	0.991

* $p < .05$
** I = Algebra, J = Pre-Calculus

Figure 1.

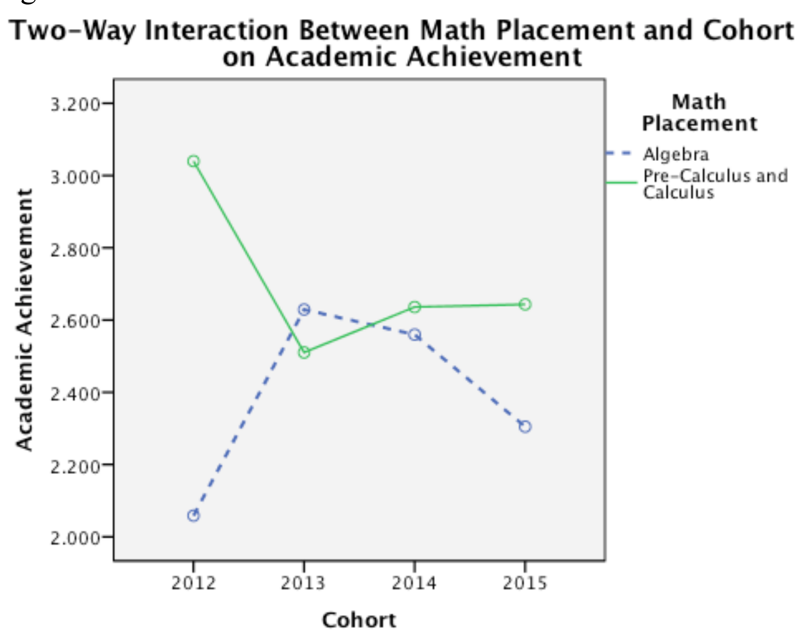


Figure 2.

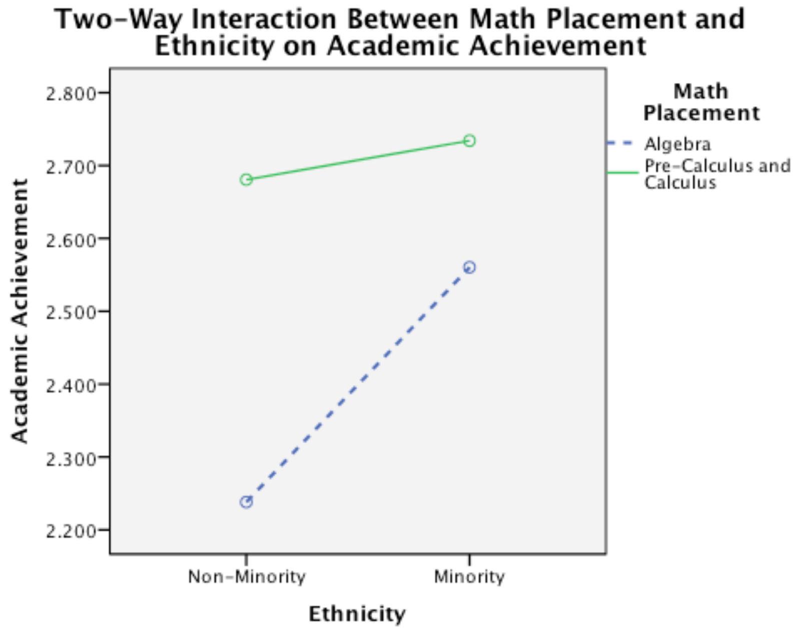
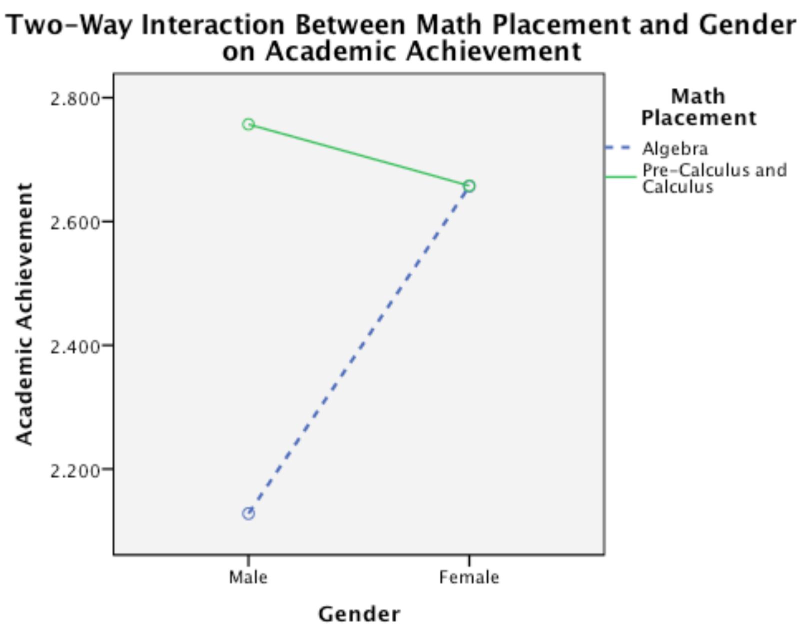


Figure 3.



In terms of main effects, there were no significant differences calculated for cohort F (3, 346) = .32, p = .81) and gender F (1, 346) = 3.60, p = .06) on academic achievement, therefore the null hypothesis was accepted for the first hypothesis. Students across the four cohorts and both genders earned GPAs that were not significantly different. However, there were statistically significant main effects for math placement, F (1, 346) = 7.57, p = .01 and ethnicity, F (1, 346) = 6.65, p = .01 on academic achievement. Students in the pre-calculus and minority groups earned higher GPAs than those in the algebra and non-minority groups, respectively.

University Retention

A hierarchical logistic regression was performed to assess the impact of a number of factors on the likelihood that participating AIMS students would be retained by the university, specifically between their first and second years. The model contained one control variable (math placement) entered into block 1 and three independent variables (cohort, gender, and ethnicity) entered into block 2. A test of the full model containing all predictors, against a constant only model was statistically significant, $\chi 2$ (3, N = 355) = 9.55, p = .023, indicating that the model was able to distinguish between students who were and were not retained by the university and that it contained at least one significant predictor of the outcome variable, university retention. In addition, the overall classification accuracy rate computed by SPSS was 93.8%, exceeding the required accuracy of 50%, indicating the model utilized was substantially better than what could be obtained by chance alone.

Table 8 presents the regression coefficients, Wald Statistics, and odds ratios for the control variable and each of the independent variables: cohort, gender, and ethnicity. According to the Wald criterion, the gender variable (p = .007) was the only variable to make a unique statistically significant contribution to the model predicting university retention, therefore the null hypothesis was accepted for the second hypothesis. The gender predictor recorded an odds ratio of 3.49 indicating a strong relationship and that female students were approximately three and a half times more likely to be retained at the university between their first and second year than male students, controlling for all other factors in the model. The lack of statistical findings for all other variables, cohort and ethnicity, while controlling for math placement, indicates that all of the groups were retained at equal rates.

Table 8

Logistic Regression Model for University Retention

Variable	B	S.E.	Wald	df	*p*-Value	OR	95% CI
Math Placement	-.559	.578	.937	1	.333	.572	.184 - 1.773
Cohort	.358	.227	2.489	1	.115	1.430	.917 - 2.230
Ethnicity	- .324	.451	.518	1	.472	.723	.299 - 1.749
Gender	1.249	.463	7.282	1	.007*	3.488	1.408 - 8.644

Note. OR = odds ration, CI = confidence interval

* $p < .05$

STEM Retention

A hierarchical logistic regression was also performed to assess the impact of the same factors on the likelihood that participating AIMS students would be retained in STEM. The model contained one control variable (math placement) entered into block 1 and three independent variables (cohort, gender, and ethnicity) entered into block 2. A test of the full model containing all predictors, against a constant only model was statistically significant, $\chi 2$ (3, N = 355) = 16.8, $p = .001$, indicating that the model was able to distinguish between students who were and were not retained in STEM and that it contained at least one significant predictor of the outcome variable, STEM retention. In addition, the overall classification accuracy rate computed by SPSS was 65.1%, exceeding the required accuracy of 50%, indicating the model utilized was substantially better than what could be obtained by chance alone.

Table 9 presents the regression coefficients, Wald Statistics, and odds ratios for the control variable and each of the independent variables: cohort, gender, and ethnicity. According to the Wald criterion, the cohort variable ($p = .000$) was the only variable to make a unique statistically significant contribution to the model predicting STEM retention supporting the third hypothesis, therefore the null hypothesis was rejected. The cohort predictor recorded an odds ratio of 1.55 indicating a strong relationship, controlling for all other factors in the model. Later cohorts were much more likely to be retained in a STEM discipline. More specifically, a one-unit increase in cohort increased the odds that a student was retained in STEM by one and a-half-times. The lack of statistical findings for all other variables, gender and ethnicity, while controlling for math placement, indicates that all of the groups were retained in STEM at equal rates.

Table 9

Logistic Regression Model for STEM Retention

Variable	B	S.E.	Wald	df	*p*-Value	OR	95% CI
Math Placement	.552	.251	4.817	1	.028	1.736	1.061 - 2.842
Cohort	.438	.111	15.614	1	.000*	1.549	1.247 - 1.925
Ethnicity	- .063	.232	.073	1	.787	.939	.596 - 1.480
Gender	.310	.254	1.493	1	.222	1.363	.829 - 2.241

Note. OR = odds ration, CI = confidence interval

* $p < .05$

Summary

The purpose of this chapter was to present the findings of the quantitative analyses of students participating in the AIMS program from 2008 through 2012. The chapter described the statistical treatment and outcome of the data with respect to cohort, gender, and ethnicity, controlling for math placement.

The multi-factor ANOVA results revealed a three-way interaction between cohort, gender, and math placement yielding three significant two-way interactions on a specific level of the third variable. The simple interaction of (1) gender and math placement was significant for the 2012 cohort, (2) cohort and math placement was significant for male students, and (3) cohort and gender was significant at the pre-calculus level.

The multi-factor ANOVA also revealed that the most significant differences in academic achievement occurred across the two levels of math placement and interacted with cohort, gender, and ethnicity. Students in pre-calculus had higher academic achievement than students in algebra specifically for the 2012 cohort, non-minorities, and male students. Math placement for all other groups had no effect on academic achievement indicating there were no significant differences in their GPAs.

The logistic regression results revealed that only one quantitative predictor could be used at the 95% confidence interval to predict university and STEM retention. This research finds that gender is predictive of university retention. Female students were three and a half times more likely to be retained at the university between their first and second years. Alternatively, cohort was predictive of STEM retention. Each of the later cohorts was one and a half times more likely to be retained in STEM than their predecessors. These results offer implications for practice and recommendations discussed in the final chapter.

Discussion

The purpose of this study was to determine if later learning community cohorts of the same recruitment and retention program would have higher rates of (a) academic achievement, (b) university retention, and (c) STEM retention when compared to earlier cohorts who experienced a less stringent application process and were exposed to fewer interventions. The results of the current study found partial support for the aforementioned hypotheses. This study found that a student's cohort, or year of participation in the AIMS learning community, was not predictive of academic achievement or university retention, after controlling for math placement, gender, and ethnicity. However, as hypothesized, cohort was predictive of STEM retention, with later cohorts much more likely to be retained in one of the STEM fields compared to earlier cohorts.

The data analysis found several important relationships outside the primary focus of the study. First, math placement was a strong predictor of academic achievement and was found to moderate the relationship between academic achievement and the other predictor variables: cohort, gender, and ethnicity. Second, minority students, controlling for all other independent variables, had higher levels of academic achievement than their non-minority counterparts. Third, gender appears to be a mitigating factor in first-year university retention. Females, controlling for all other independent variables, were much more likely to be retained at the university between their first and second years than male students. Fourth, academic achievement in the first year was positively correlated with university and STEM retention. Lastly, first-year university retention was positively correlated with STEM retention.

Cohort

The primary predictor of student success in any educational endeavor is an academically successful first year (The National Center for Education Statistics, 2009). The current study is unique in its examination of first-year academic achievement, first-year retention, and STEM retention in successive learning community cohorts receiving varying levels of academic interventions. It is hypothesized that students who have expressed interest in STEM learning communities and have gone through a more stringent application process, indicating higher levels of motivation, would have experienced greater academic success and retention when provided with access to increased academic support and interventions.

The statistical models used in this study did not find significant results between cohort and academic achievement or university retention for the participants included in the study. All four cohorts had comparable GPAs and first-year retention rates. However, as expected, controlling for all other factors in the model, cohort was found to be predictive and positively contributed to STEM retention. Later cohorts were not only retained in STEM disciplines at higher rates, but students were one-and-a-half times more likely to be retained in a STEM major than the previous cohort.

Successful retention programs begin with the admissions process (Tinto, 1982) and should recruit the most interested and capable students, and then provide them with the necessary academic resources and educational experiences to make it through the "pipeline" (Atkinson & Mayo, 2010). The student involvement that occurs as an outcome of learning community participation results in higher educational achievement and increased persistence (Leonard, 1996). However, this approach is highly dependent upon the student and their level of interest and academic proficiency as well as the institution's ability to provide an environment in which the student can succeed (Reid, 2009).

Academic Achievement and Math Placement

Although cohort was not found to be a statistically significant predictor of academic achievement the results of the current study found that math placement proved to be a highly predictive variable. Students with higher math placements have typically performed better under the rigorous demands of higher education (Thiel et al., 2008). Consequently, math placement is a very important factor in determining which STEM students will require additional support and resources to succeed in their first year of undergraduate studies. Those who place into remedial math courses, like algebra, are considered at-risk because they haven't acquired the academic skills necessary to succeed in their introductory STEM courses and other higher-level courses found at the college level (Johnson, 2012). However, based on the results of this study, it is clear that students enrolled in algebra, controlling for other factors, are able to demonstrate a level of academic achievement that is comparable to their pre-calculus peers. Although previous studies have indicated that under some conditions higher math placement is linked to higher academic achievement, the results of this study indicate that under different conditions, like those provided by a learning community, there is no relationship between math placement and academic achievement.

In this study, math placement impacted the academic achievement outcomes between the cohorts. genders, and ethnicities. Across the interaction variables, students in pre-calculus performed significantly better than students in algebra, but only on one level of each predictor. These results indicate that for all other conditions the academic achievement between pre-calculus and algebra students were not significantly different contrary to studies suggesting students with lower math placements are at an academic disadvantage.

The academic achievement among the cohorts by math placement was statistically significant for the 2012 cohort with pre-calculus students earning higher GPAs. The lack of statistically significant differences among the 2013, 2014, and 2015 cohorts indicate that math placement did not contribute to their academic achievement. Pre-calculus and algebra students performed similarly during the later three years of the program, indicating that the gap between the math placements was bridged.

The two-way interaction between math placement and gender on academic achievement indicated that males in pre-calculus performed better academically than those in algebra. The level of math placement had no impact on the academic achievement among females. While there was no significant difference in academic achievement between the genders, females performed equally across math placements indicating their level of math skills did not affect their overall academic performance, unlike their male counterparts.

According to the statistically significant main effect for ethnicity, students in the minority group earned overall higher GPAs than those in the non-minority groups during their first year. Furthermore, the two-way interaction between math placement and ethnicity indicated that non-minorities in pre-calculus had higher academic achievement than non-minorities in algebra. While these results highlight the differences by math placement among non-minorities, they also suggest that minorities in both pre-calculus and algebra experienced similar academic achievement.

The study hypothesized that there would be significant differences in achievement and retention by cohort. Although significant math placement interactions impacted the findings, they positively contributed to the program goals. The results found that the algebra students in the latter three cohorts, who received significantly more interventions, did not have significantly lower GPAs than the pre-calculus students in the same cohorts, as prior research would suggest (Thiel et al., 2008). Furthermore, the program goal was to increase the recruitment and retention of women and underrepresented minority students in STEM and the results confirm that minority students had higher academic achievement overall, while both minorities and women performed equally across math placements.

Retention of Women and Underrepresented Minorities

Retention and recruitment programs have been developed to specifically provide women and underrepresented minorities with the academic support they require to experience STEM success. However, programs intended to support women found that they continued to leave for reasons similar to their minority counterparts (Civian & Schley, 1996), who continue to experience retention rates that are 20% to 30% lower than whites and Asians, respectively (Anderson & Kim, 2006). Attrition reasons included both environmental and social-cognitive factors. Environmental factors were based mainly on the lack of support from the learning environment and faculty (Fear-Fenn & Kapostasy, 1992; U. S. Department of Education/NCES, 2000). Although, institutional factors like course workload and the time required to complete a STEM degree also influenced student decisions (Seymour, 1992). Internal factors included their perception of STEM relevance (Fear-Fenn & Kapostasy, 1992) and low self-confidence (Seymour & Hewitt, 1997; Ware & Lee, 1988).

First-Year Retention. The research is clear that the first and second years are the most influential in a student's decision to continue their undergraduate career (Johnson, 2012; Business Higher Education Forum, 2011). Less than 50% of students with STEM intentions graduate with a STEM degree and more than 30% of these students leave between their first and second years (Business Higher Education Forum, 2011). Despite the statistics, the importance of first-year retention is often overlooked in studies specifically evaluating STEM retention programs where the primary focus is the end product of the undergraduate career as opposed to the beginning. Program evaluation studies have examined undergraduate and graduate STEM retention with respect to the institutional factors and supportive integration practices that contributed (Gardener, Barefoot, & Swing, 2001; Braxton, Brier & Steele, 2007; Walker & Schultz, 2001; Tinto, 1993; 2004, Kremer & Bringle, 1990). Meanwhile, studies assessing first-year retention have gauged STEM intention not retention (Clounch, 2010).

Similar to academic achievement, the study hypothesized that later cohorts participating in the AIMS learning communities would be retained at higher rates between their first and second years. The results of the study did not support this hypothesis, but yielded information supporting the program's intentions to retain women and minorities. The lack of statistically significant findings for cohort and ethnicity, controlling for math placement indicates that these groups were retained at equal rates. Prior studies indicate that minorities are retained in STEM at much lower rates than non-minorities (U.S. Department of Education, 2000). However, there were no differences in first-year retention between the minorities and non-minorities in this study. Additionally, gender, controlling for all other variables, was predictive and positively contributed to first-year university retention. Contradictory to recent literature (Chubin & Malcolm, 2006), the females intending to pursue STEM degrees in this study were much more likely to be retained from the first to the second year. They were three and a half times more likely to be retained than their male peers. The results of this study suggest that with increased academic support, such as participation in a learning community, minorities and females no longer have lower first-year retention rates, but can match non-minorities and exceed that of males, respectively.

STEM Retention. There are significant gaps in national STEM retention rates related to gender and ethnicity. Women and minorities have lower STEM retention rates than men and non-minorities (U.S. Department of Education, 2000). The STEM retention rate of minorities in the present study were not lower, but comparable to that of non-minorities. However, minorities in the present study had significantly higher academic achievement than non-minorities. Although the STEM retention rates of both ethnic groups were similar, results also indicated that higher academic achievement was correlated with higher STEM retention representing potential for increased STEM retention among minorities. All other variables were not significant for STEM retention indicating both genders and ethnicities were retained at equal rates. Contrary to national retention rates (U.S. Department of Education, 2000), males and females, and non-minorities and minorities in this study had comparable STEM retention rates.

Correlation Between Academic Achievement, University Retention, and STEM Retention

The literature on retention indicates that academic and social integration exerts the most influence on persistence and achievement in higher education settings like universities (Pascarella & Terenzini, 1991). Learning communities, like AIMS, focus primarily on integrating their students, both academically and socially, to strengthen their attachment with their institution during their first year.

Significant correlations were found among the outcome variables in this study. First-year academic achievement was positively correlated with both first-year university retention and STEM major declaration. The students in the AIMS learning communities who experienced first-year success, with higher GPAs, were more likely to continue their educational endeavors at the university and pursue their originally intended STEM degree. Meanwhile, the students earning lower GPAs in their first year had higher rates of university attrition and major declaration in fields other than STEM. In addition, first-year university retention was positively correlated with STEM retention. Students who were retained by the university between their first and second years had higher rates of STEM retention.

Prior studies have determined that an academically successful first year is the primary predictor of student success in their major and college graduation (The National Center for Education Statistics, 2009). Therefore, it is no surprise that significant correlations were found among the outcome variables in this study, as the findings are consistent with prior research.

Limitations and Future Directions

This study was conducted as an evaluation of the Achievement in Math and Science (AIMS) learning communities at RU. No other learning communities at RU or at other institutions were included in this study. The profile of the institution is a large public university situated in an urban region of central New Jersey and the majority of students are New Jersey residents. Overall, RU has very high first-year retention rates. According to the U.S. News and World Report (2014), the average freshman retention rate at Rutgers – New Brunswick is 92% whereas the national average is 65% (ACT, 2008). Therefore, significant differences in first-year retention at RU will be more difficult to achieve than at other universities with lower first-year retention. The conclusion of the study will be most helpful to institutions and programs with similar attributes.

Participants. There are several limitations to consider regarding participant recruitment and demographics. The program was offered to all first-year students meeting the eligibility requirements, but participants ultimately self-selected into the program. Consequently, a selfselection bias might have had an influence on these findings. Random assignment would improve the design of the study, but can be difficult to achieve in a retention program requiring participants to have high levels of commitment prior to starting the program. This study then compared the participating AIMS cohorts, but did not include a true control group. The invited students who declined participation were not included in the study as a comparison group. Thus, analyses between participants and eligible non-participating students with similar demographics would provide information in addition to that provided by the cohort comparisons. Although the program intended to recruit only women and underrepresented minorities, due to the low rate of applications, white and Asian males were invited to fill the program. Therefore, the results of the study are inclusive of women and underrepresented minorities as well as white and Asian males. Consideration should be given to the generalizability of the results to target groups.

Program. The AIMS learning communities are part of a 5-year grant, however, this study examined partial outcomes of the program in its first four years of operation. Thus additional evaluation of the program will need to occur as the program evolves over the course of the grant to determine if the results still hold true. The data collected when the last participating cohort has graduated will also provide the opportunity to conduct comprehensive analyses with additional variables.

The data collected and analyzed in this study are specific to the hypotheses and present certain limitations. The study examined the first-year retention rates of students between their first and second years. It does not account for any students leaving the university or returning after that specific data point. It also examined STEM retention in the student's fifth semester, but does not capture true undergraduate STEM retention, which is graduation in a STEM discipline. At the time of data collection, this information was not available for all of the cohorts included in the study. Future studies should measure STEM retention by graduation to eliminate the chance of a major change after the fifth semester. Additional studies should also analyze STEM retention by subject area to identify the disciplines with the highest and lowest rates of retention. The results would be useful in creating communities specific to those disciplines.

Implementation Fidelity. The AIMS program targeted early intervention, academic and social integration, and academic skill-building as key components of STEM student success. However, a measure of implementation fidelity was not utilized to ensure the program was implemented in the way in which it was intended. Programs with high fidelity are significantly more successful than poorly implemented programming (Carroll, Patterson, Wood, Booth, Rick, & Balain, 2007). It is suggested that a measure of implementation fidelity is used in the future so that outcomes can be attributed to the program and future implementation can be improved.

This study identified the increased quantity and quality of interventions by cohort, but did not measure student use. The program offered services throughout the first year, however students had varying levels of participation. They did not partake in all interventions or to the same degree. In addition, only some students took advantage of the clustered science and introduction to research courses offered in the spring semester. Therefore, they were the only students to be enrolled in linked courses during the second semester. These varying levels of participation are not accounted for in this study. Future studies should more closely examine the level of student participation within the program. In addition to student use, the degree of change in each program element was not measured. The interventions need to be coded to reflect their weight and student participation measured by attendance. Retention programs spend a significant amount of time, money, and energy to provide resources to students, but availability does not necessarily mean they were implemented with integrity or utilized by participants.

Additional Variables. Provided there is an ample sample size, the differences between minority groups are also worth exploring. The goal of the program was to increase the retention of minority students in STEM and while this study identified differences between minority and non-minority students, it did not identify which ethnicities had the highest and/or lowest academic achievement and retention. Thus the identification of groups that are most/least likely to experience success would lead to more individualized programming and support.

Students have successfully made it through the STEM pipeline when they have entered the STEM workforce, but have many opportunities to leak out along the way. STEM graduation indicates they have made it through another leaky juncture, but the collection of data on students' post-graduate plans can give us a better idea of how many will actually enter the STEM workforce based on early predictor variables. Students pursuing graduate programs in STEM are one step away from making it through the pipeline while those employed in a STEM field have made it through. Retention rates get smaller as students move through the pipeline, but the fundamental goal of all retention programs is to add to the STEM workforce. The addition of graduate and employment data has the potential to provide valuable information on predictive variables that can be used to develop early interventions programs and successful STEM students.

Statistical Limitations. The predictor variables included in this study were limited to cohort, math placement, gender, and ethnicity as they were specifically of interest. It is important to note that students were nested in different schools at the university as well as communities within AIMS. The analyses conducted did not indicate the difference in outcomes by school or AIMS community and it is a possibility that higher outcomes may be associated with either one. In addition, adding more variables to the model, specifically the logistic regression, would decrease the case to variable ratio and increase the standard error. With the addition of participants, more predictor variables can be added to the model and it is suggested that this is attempted when the data for all five cohorts is available.

Analyses examining the possibility of protective properties including interactions terms among the variables were not conducted in the logistic regression and are suggested for future research. Although math placement, cohort, ethnicity, and gender were entered as covariates, they were not entered into the regression model as two- and/or three-way interaction terms. The use of these interactions in the regression model accounts for the level of risk and has the potential to provide information regarding stronger protective effects. For example, the presence of culturally specific effects may indicate that certain ethnicities may have multiple risk factors and require more protective factors to compensate.

Research in the area of STEM attrition and retention, specifically for underrepresented minorities and women, has been growing steadily in recent years. As programs are developed and implemented, universities are anxious to examine the impact their efforts have made. As the findings in this study show, there is no single contributor to STEM retention. Additional quantitative studies of first-year retention programs need to be conducted to validate the findings from this study and to increase the knowledge and understanding of the predictive factors and interventions that promote the retention of women and minorities in STEM programs. Additional variables, under the right conditions, such as those created by the AIMS learning communities, have the potential to yield information that could help target specific program elements and subsets of the intended populations. These variables would add to the existing literature and contribute greatly to our understanding of STEM retention as it pertains to women and specific underrepresented minority groups.

Summary and Implications

The nation must increase the production of STEM professionals by 34% annually for the next decade to meet the needs of economic projections (President's Council of Advisors on Science and Technology, 2012). Women and underrepresented minority groups are predominant in the population (Jackson, 2006), but are disproportionately represented in STEM (Chubin & Malcolm, 2006), and although efforts to recruit and retain these groups have increased, they have fallen short (Reid, 2009). The lack of STEM professionals in our country is due to inadequate academic preparation and support, but also individual interest. Students who have expressed interest in STEM, but don't have the appropriate educational foundation, require academic support to develop the time management, organization, and study skills needed to succeed in a demanding STEM program. Based on previous studies, it is anticipated that with increased student involvement and additional academic support women and minorities will persevere in their undergraduate career in STEM disciplines at greater rates (Barefoot 1993, 2000; Barefoot, Warnock, Dickinson, Richardson, & Roberts, 1998; Tinto, 1999).

Despite the current emphasis placed on the recruitment and retention of women and minorities in STEM disciplines, little research has focused on first-year academic achievement, first-year university retention, and STEM retention among participant groups of the same program. The findings from this study have direct implications for the improvement of current and development of future STEM retention programs. The review of STEM retention literature reveals that math placement, gender, and ethnicity as they relate to first-year academic achievement, first to second year retention, and STEM retention have not been emphasized. Furthermore, the predictive nature of these variables on early outcomes has been overlooked.

Given the current focus on increasing STEM professionals, the results of this study could serve as a source of reference to design programs intended to meet the specific needs of these students as well as provide valuable information that will save universities time and money. Starting with university enrollment and STEM recruitment, institutions can now increase the intensity of application processes for STEM retention programs with the understanding that pre-entry engagement and motivation is a key factor in STEM success. Institutions need to be cautious about investing resources in students with little personal interest in pursuing STEM careers, therefore, it is imperative that recruitment efforts identify students with academic promise for STEM careers as well as personal interest and motivation to pursue such careers. In determining the student characteristics coupled with program aspects highly associated with retention, institutions are able to identify the students most likely to succeed when provided with access to additional academic support. The findings push higher education institutions to be more proactive and intentional while respecting emerging adults' needs for autonomy and structure.

The study attempted to develop a greater understanding of the impact of increased interventions across cohorts, but was more useful in finding significant results between math placements, genders, and ethnicities. Regardless, the findings from this study will offer new insight and contribute to the pre-existing STEM retention literature. Math placement, gender, and ethnicity are supported in the literature as contributors to academic achievement and retention (Thiel et al., 2008; U.S. Department of Education, 2000). There are significant gaps in STEM retention rates related to these factors. Contrary to prior studies and based on the results of this study, it is clear that (a) algebra students can experience academic achievement comparable to their pre-calculus peers, (b) women were much more likely than men to be retained between the first and second years, and (c) minorities had significantly higher academic achievement than non-minorities. Although the STEM retention of both ethnicity groups was similar, results also indicated that higher academic achievement was correlated with higher STEM retention. This study illustrates that the existing gaps between math placements, genders and ethnicities, as they pertain to STEM retention, have the potential to be bridged.

Using a quantitative approach, this research has highlighted the importance of math placement and purposeful first-year programs as it pertains to the STEM retention of women and minority undergraduate students. These students are at greater risk of attrition without academic support. It also alludes to the impact and importance of selecting specific evidence-based academic interventions for retention programs. Whole program evaluations are essential, but it is difficult to attribute success to any one variable. Therefore, additional research on individual student characteristics and program elements are advisable for greater understanding of the factors that impact STEM attrition and retention.

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Appendix A

Table 1.

AIMS Participants by Community and Cohort

Program	2008-2009	2009-2010	2010-2011	2011-2012
AIMS Residential – Busch Campus	31	38	39	43
AIMS Residential – Cook Campus	N/A	44	28	29
AIMS Multi-Campus	23	N/A	N/A	N/A
AIMS Commuter – Non-Residential	17	27	21	18
Total Students	71	109	88	90

Appendix B

Table 1.

STEM Majors in the School of Arts and Sciences and School of Environmental and Biological Sciences

Code	Major
002	Pre-Pharmacy
004	Engineering (4 year)
005	Engineering (5 year)
008	Pre-Nursing
017	Agricultural Science
019	Agroecology
020	Agriculture & Food Systems
045	Allied Health Technologies
067	Animal Science
071	Anthropology - Evolutionary
073	Applied Sciences in Engineering
100	Astronomy
105	Astrophysics
107	Atmospheric Science
110	Bacteriology
112	Behavioral & Neural Sciences
115	Biochemistry
116	Bioenvironmental Engineering
117	Bioenvironmental Engineering (5 year)
118	Computational Biology & Molecular Biophysics
118	Biomaps
119	Biological Sciences
120	Biology
121	Biology: Computational & Integrative
122	Biomathematics
123	Biomedical Engineering (5 year)
123	Biology - Environmental
124	Biomedical Technology
125	Biomedical Engineering (4 year)
126	Biotechnology
127	Bioresource Engineering
130	Botany
131	Botany & Plant Physiology
146	Cell Biology & Neuroscience

Table 1.

STEM Majors in the School of Arts and Sciences and School of Environmental and Biological Sciences (continued)

Code	Major
146	Neurobiology
148	Cell & Developmental Biology
150	Ceramic and Materials Science & Engineering
155	Chemical & Biochemical Engineering
155	Chemical Engineering
156	Chemical Engineer (5 year)
158	Chemical Biology
160	Chemistry
160	Chemistry & Chemical Biology
180	Civil & Environmental Engineering
180	Civil Engineering
181	Civil Engineer (5 year)
191	Clinical Lab Sciences
198	Computer Science
215	Ecology & Evolution
216	Ecology, Evolution, & Natural Resources
254	Mathematics Education
256	Science Education
332	Electrical & Computer Engineering
333	Electrical & Computer Engineering (5 year)
340	Endocrinology & Animal Biosciences
370	Entomology
373	Environmental & Business Economics
374	Environmental Policy, Institutions, & Behavior
375	Environmental Sciences/Studies
377	Exercise Science & Sport Studies
379	Equine Science
380	Environmental Geology
400	Food Science
440	General Engineering
447	Genetics
450	Geography
460	Geological Sciences
460	Geology
465	Geoscience Engineering
540	Industrial Engineering

Table 1.

STEM Majors in the School of Arts and Sciences and School of Environmental and Biological Sciences (continued)

Code	Major
540	Industrial & Systems Engineering
541	Industrial Engineering - 5 Year Program
544	Information Technology
546	Integrative Neuroscience
547	Information Technology & Informatics
548	Information Systems
550	Landscape Architecture
628	Marine Sciences
635	Materials Science & Engineering
640	Mathematics
642	Applied Mathematics
643	Mathematics
645	Mathematical Sciences
650	Mechanical Engineering
650	Mechanical & Aerospace Engineering
651	Mechanical Engineering (5 year)
660	Medical Technology
663	Medicinal Technology
670	Meteorology
680	Microbiology
681	Microbiology/Molecular Genetics
682	Microbial Biology
694	Molecular Biology & Biochemistry
695	Molecular Biosciences
696	Molecular Biophysics
704	Natural Resource Management
704	Ecology & Natural Resources
705	Nursing
709	Nutritional Sciences
710	Neuroscience
711	Operations Research
712	Oceanography
714	Perceptual Science
715	Pharmaceutical Chemistry
717	Pharmacognosy
718	Pharmacology, Cellular, & Molecular

Table 1.

STEM Majors in the School of Arts and Sciences and School of Environmental and Biological Sciences (continued)

Code	Major
720	Pharmaceutical Science
720	Pharmacy
742	Physical Therapy
750	Physics and Astronomy
750	Physics
755	Physics Applied
760	Physiology
761	Physiology & Integrative Biology
765	Plant Biology
770	Plant Pathology
776	Plant Science
778	Plant Science & Technology
780	Plant Physiology
832	Public Health
890	General Science
960	Statistics
961	Statistics - Mathematics
963	Toxicology
990	Zoology & Physiology

Appendix C
Recruitment & Intervention Changes by Cohort

Table C1.

AIMS Communities

	2008-2009	2009-2010	2010-2011	2011-2012
Residential				
Busch Campus – Davidson	✓			
Busch Campus – Metzger		✓	✓	✓
Cook Campus – Perry		✓	✓	✓
Non-Residential				
Multi-Campus	✓			
Commuter	✓	✓	✓	✓

Table C2.

Recruitment & Application Process

	2008-2009	2009-2010	2010-2011	2011-2012
Recruitment				
Summer	✓			
Spring		✓	✓	✓
E-Mail	✓	✓	✓	✓
Follow-Up Letter	✓	✓	✓	✓
Reminder E-Mail	✓	✓	✓	✓
Phone-a-Thon		✓	✓	✓
Campus Visits		✓	✓	✓
Orientation		✓	✓	✓
Summer Bridge		✓	✓	✓
Postcard			✓	✓
STEM Reception – SEBS				✓
Application Process				
Electronic Application	✓	✓	✓	✓
Brief Interview & Rubric		✓	✓	✓

Table C3.

Intervention: Peer Mentoring

	2008-2009	2009-2010	2010-2011	2011-2012
Peer Mentors				
Non-Residential Peer Mentors	✓	✓	✓	✓
Residential Peer Mentors		✓	✓	✓
Peer Mentors Recruitment/Application				
Faculty Nominations	✓	✓	✓	✓
Campus Newspaper		✓	✓	✓
Student Listervs		✓	✓	✓
STEM Groups		✓	✓	✓
SAS Honors Program		✓	✓	✓
School of Engineering		✓	✓	✓
SEBS		✓	✓	✓
Sophomore STEM Classes		✓	✓	✓
Previous AIMS Cohort(s)		✓	✓	✓
Previous Peer Mentors			✓	✓
EOF			✓	✓
Douglass			✓	✓
ODASIS			✓	✓
Application & Essay	✓	✓	✓	✓
Recommendation		✓	✓	✓
Individual Interview	✓	✓	✓	✓
Group Interview (Res Only)		✓	✓	✓
Peer Mentor Training				
"Mentor-to-Mentor"	✓			
Matched By Likes/Dislikes	✓			
Matched By Discipline			✓	✓
Spring – 3 Days		✓	✓	✓
Summer – 3 Days		✓	✓	✓
Monthly Mentor Meetings		✓	✓	✓
Peer Mentor Supervision				
RU-STEP Staff	✓	✓		
Monthly Logs	✓	✓	✓	✓
AIMS Graduate Advisor			✓	✓

Table C4.

Intervention: Programming & Support

	2008-2009	2009-2010	2010-2011	2011-2012
Meet Your Mentor – Late Sept.	✓			
FIGS	✓			
Orientation/Early Move-In		✓	✓	✓
Fall Meet & Greet – 1st Friday		✓	✓	✓
4 Residential Programs/Semester		✓	✓	✓
1 Commuter Program/Semester		✓	✓	✓
Physics of Bowling		✓	✓	✓
Great Beginnings		✓	✓	✓
Commuters Attend 1 w/PM			✓	✓
Academic Success Strategies				
Study Smarter Not Harder		✓	✓	
2 Writing Workshops		✓		
Academic Advising (Fall)		✓	✓	✓
Academic Planning (Spring)		✓	✓	✓
Tutoring				
Math Tutoring	✓	✓	✓	✓
Math Tutoring Increased		✓	✓	✓
Chemistry Tutoring			✓	✓
Chemistry Tutoring Increased				✓
ALEKS Program			✓	✓
AIMS Graduate Advisor			✓	✓
Office Hours: In-Residence			✓	✓
Office Hours: In ARC				✓
Early Warning			✓	✓
Early Warning Increased				✓

Table C5.

Intervention: FIGS & Linked Courses

	2008-2009	2009-2010	2010-2011	2011-2012
FIGS				
Returning PIs	✓			
General Training	✓			
New PIs		✓	✓	✓
AIMS Specific Training		✓	✓	✓
Fall Linked Courses				
Writing	✓	✓	✓	✓
Math	✓	✓	✓	✓
Introduction to Research				✓
Spring Linked Courses				
General Biology 102		✓	✓	✓
General Chemistry I		✓	✓	✓
General Chemistry II/Lab		✓	✓	✓
Writing		✓	✓	✓
Intro to Research – 1 Section		✓		
Intro to Research – 2 Sections			✓	✓

Appendix D
Codebook

Table 1.

Code Book

Variable	SPSS Variable Name	Coding Instructions
Program Year	Cohort	1. 2008-2009 2. 2009-2010 3. 2010-2011 4. 2011-2012
Math Placement	Math_Placement2	1. Algebra 2. Pre-Calculus & Calculus
Gender	Gender2	1. Male 2. Female
Ethnicity	Ethnicity2	0. Non-Minority 2. Minority
Grade Point Average	GPA	GPA on a 4.0 Scale
University Retention	Univ_Ret2	0. No 1. Yes
STEM Retention	STEM_Retention	0. No – Other declaration 1. Yes – STEM declaration

Appendix E

The Rutgers University, Student Talent Expansion Program (RU-STEP)

Achievement in Math and Science (AIMS) Learning Communities

Detailed Program Changes

The model for the AIMS learning communities is best described as a linked courses model with a freshman interest group. The AIMS commuter and residential learning communities were launched in fall 2008 with the following program elements in place: preferential recruitment, linked courses, residential and non-residential learning communities, common residential experience, a mentoring program, academic programming, academic success strategies, tutoring support, a graduate advisor, and an early warning system. A description of each element and the progression of the changes across cohorts follow.

Recruitment Process

Students were recruited based on school, math placement results, intended major, gender, and race/ethnicity. Students in the School of Art and Sciences (SAS) and the School of Environmental and Biological Sciences (SEBS) were eligible to participate. The regularly administered Rutgers placement exam was used to identify the SAS and SEBS students who placed below the calculus level, in elementary algebra, intermediate algebra, or pre-calculus. Basic skills mathematics courses are those below the pre-calculus level. Elementary algebra and intermediate algebra are basic skills mathematics courses and are remedial at RU.

Data on preferred major was collected by the Admissions Office and used to identify students intending to pursue a science, technology, or math discipline. All women and underrepresented minority males, which excluded white and Asian males, were eligible to participate. White and Asian males were originally deemed ineligible based on ample representation in STEM fields, however due to the availability of spaces they were later invited to participate making the communities open to all first-year students fitting the other eligibility criteria. The first-year deans of SAS and SEBS provided lists of students fitting the recruitment profiles on a rolling basis.

2008-2009. In 2008, eligible students were initially contacted via e-mail informing them of their eligibility, describing the benefits of the program, and inviting them to join. They received a follow-up letter via mail and an e-mail reminder prior to the deadline. Students were also provided with contact information to ask questions or get additional information. All students who submitted the electronic application were admitted into the program.

2009-2010. In 2009, a multifaceted recruitment strategy was employed to provide students with information multiple times and in a variety of ways. The first phase of recruitment began in April. Eligible students were initially contacted via e-mail. The e-mail congratulated them on their eligibility and contained program descriptions for the AIMS learning communities and the Summer Bridge programs, which was found to confuse students and inhibit responses. Letters were sent home, generating a larger response because parents read the letter and then encouraged their children to apply. The Office of Learning Communities conducted a two-phase phone-a-thon. Undergraduate student employees called incoming first-year students to ask if they received the e-mail and letter, provide additional information about the learning communities, and answer any questions they may have. In addition to isolated departmental efforts, incoming first-year students were provided with information on various occasions during their campus visits, which included the Rutgers Open House, an invitation to a special STEM Welcome Reception at the University Open House, their Academic Planning and Advisement (APA) Day, and their 2-day Orientation. Specific learning community sessions were held during the APA and

Orientation Days. In addition, information about the AIMS learning communities was also provided during the Residence Life and Commuter Life Orientation sessions. Students participating in the RU-STEP Summer Bridge Program were recruited into the AIMS communities in the summer.

Students were required to submit an electronic application and complete a brief 15-minute phone interview with an AIMS peer mentor. An interview rubric was created to gauge the student's STEM interest. The mentor completed the rubric after the interview and the student was recommended if they were appropriate for the community. The interview questions provided students with a better understanding of the AIMS program, learning community components, and commitment requirements. It helped to clear misconceptions, gave them the opportunity to ask questions, and allowed wavering students to change their minds earlier in the recruitment process. One challenge to the residential recruitment process was the tendency of students to delay taking their placement exams. The list of residential learning community students was due to housing before all students took their placement exam, automatically excluding potentially eligible students.

2010-2011. In 2010, a multifaceted recruitment strategy similar to the previous year was employed, but there were some modifications and additional approaches. It consisted of e-mail invitations, letters, phone-a-thons by PMs, and post card follow-up. Recruitment suggestions were solicited from PMs, who suggested the follow-up postcard and simplification of invitation text while highlighting key features of the program. They also volunteered to conduct the Phone-a-Thon after high school ended in June to promote the learning communities and answer questions. In addition to departmental efforts, The Rutgers Summer Orientation is offered 18 times during the course of the summer and includes three different learning community sessions:

a general learning community session, a commuter focused session, and a residential learning community focused session. The orientation staff leading the sessions made specific announcements about the AIMS communities and referred students accordingly. Using the list of students from the commuter and resident specific Orientation sessions allowed for targeted invitations to each group highlighting the benefits of their respective AIMS program. The application process was similar to those reported in the previous year. However, the AIMS PMs and graduate advisor conducted the phone interviews.

2011-2012. The recruitment process closely resembled the previous year with minimal changes. Due to the low number of SEBS students at the 2010 STEM reception, the event was more heavily advertised. A printed brochure containing all of the STEM programs on campus were distributed at the event. The increased program visibility and information session availability doubled the SEBS applicants from the previous year. The application process remained the same with the AIMS PMs and graduate advisor conducting the phone interviews.

FIGS and Linked Courses

Following the linked courses model, students were co-enrolled in three first-year courses required for science and math majors. The AIMS students were automatically placed into the one credit "Exploring Careers in the Sciences" FIGS course created and reserved exclusively for AIMS students. The residential and commuter communities had their own sections. Students were then placed in a cluster of two additional courses consisting of their respective section of math and expository writing. However due to scheduling conflicts they were not all placed into the same sections and their linked sections also contained non-AIMS students. Students were placed in one of four mathematics courses: Intermediate Algebra 26, Pre-calculus 111, Pre-calculus 112, and Pre-calculus 115, which is an advanced combination of 111 and 112. AIMS students are advised to take the two-semester sequence, 111 and then 112, rather than the one semester version, 115, because their academic skills require more development. There were reserved sections of math and writing in the fall and biology and chemistry for eligible students in the spring.

At RU, FIGS is a one-credit seminar instructed by trained upper-class students called Peer Instructors (PI). The FIGS program has been in existence for more than a decade. FIGS are available to first-year students in the School of Arts and Sciences (SAS), School of Environmental and Biological Sciences (SEBS), and Rutgers Business School. This 10-week orientation course is limited to 25 students and is offered in a range of topical areas that currently include: Animal Science, Anthropology, Culture, and Perspectives, Art and Art History, Asian American Studies, Business, Chemistry, Communication, Community Activism and Civic Engagement, Computer Science, Dental Professions, Ecology and Natural Resources, Education, English Literature, Environmental Policy and Awareness, Food Science, Foreign Language and Linguistics, Health and Medicine, History, Journalism, Latin American Culture, Law and Leadership, Mathematics, Nursing, Nutrition, Philosophy, Plant and Agricultural Science, Political Science, Psychology, Social Work, Theater, Veterinary Medicine, Women's and Gender Studies, Sociology, and Sports Psychology. Learning Community students are automatically assigned to and enrolled in the FIGS course designated for their community. The FIGS serves as an orientation course designed to acclimate students to their new environment and includes 11 elements: a supportive learning environment, information literacy, tools for academic success, academic planning and requirements, out of class excursions, diversity/multiculturalism, peer perspective, personal wellness, faculty connections, career development, and a final culminating project.

The FIGS Peer Instructor (PI) application is highly selective. Upperclass students complete an online application, a group interview, and an individual interview where they are required to teach a lesson of their choice to the interview panel. Learning Community information is included in the application where interested applicants can indicate their interest. PIs teach one FIGS section and are co-enrolled in a 3-credit Peer Education course. Due to the additional time commitment, responsibilities, and training associated with the learning communities, AIMS PIs received an additional stipend.

The Exploring Careers in the Sciences FIGS was developed specifically for the AIMS communities and focused on exposing students to a wide variety of careers across STEM disciplines. Each student is assigned a career to research and must prepare a poster to present in class. The poster is then displayed at the annual AIMS Career Showcase and Alumni Panel event held in November.

2008-2009. PIs are selected and trained annually and typically only teach a FIGS course once in their undergraduate career. However, at the time the program was funded in 2008, the PI selection and training process was complete and so the FIGS instructors assigned to the AIMS communities were former PIs with science backgrounds. The normal process was followed in succeeding years. There were 4 sections of the FIGS Exploring Careers in the Sciences to accommodate for the residential (2), the commuter (1), and the multi-faceted (1) communities.

2009-2010. In 2009, the FIGS directors conducted their application and selection process incorporating the AIMS learning communities. PIs were selected and trained specifically for the Exploring Careers in the Sciences sections. It was explained that these sections required an increased time commitment. PIs attended portions of the spring PM training and were required to attend the monthly meetings in the fall to discuss their mutual students and ensure collaboration between the peer leaders. In addition, they coordinated the Career Showcase and Alumni Panel event comprised of three parts: the poster display, the awards reception, and the STEM Alumni panel. There were 6 sections of the FIGS Exploring Careers in the Sciences: two sections for the Metzger Hall – Busch Campus, two sections for the Perry Hall – Cook Campus, and two sections for the commuters.

In the fall semester, students were automatically co-enrolled in their respective writing and math courses. In the Spring semester students were given options for pre-registration for selected classes: General Biology 102, General Chemistry I, General Chemistry II with a Lab, a writing course, and a newly designed 1.5 credit Introduction to Research course. The science courses had prerequisites and only eligible students were permitted to enroll. The Introduction to Research course was offered to all first and second-year STEM students with the intention of introducing students to the basic elements of scientific research. Students were required to read and analyze scientific papers and present scientific material.

2010-2011. The FIGS and Linked courses were similar to those reported in the previous year. However, two sections of the Introduction to Research course, taught by graduate students, were offered in Spring 2011 due to high enrollment.

2011-2012. There were no changes made to the linked courses. Students were placed into their respective sections of the FIGS, mathematics, and writing courses. However, one section of the Introduction to Research Course was offered in fall 2011 and two sections were offered in spring 2012. The course continued to be taught by graduate students.

AIMS Communities

A comprehensive list of AIMS programs by year and their corresponding participants can be found in Appendix A.

2008-2009. In 2008, there were three communities, one residential community on the Busch Campus, one commuter community for non-residential students, and a multi-campus community for students who lived on-campus, but not in the residential learning community. The multi-campus community was discontinued in subsequent years.

2009-2010. In 2009, an additional residential community on the Cook Campus was added to the pre-existing residential community on the Busch Campus and the commuter community for non-residential students. The Cook Campus community was not originally scheduled to begin until the third year of the program, however it was implemented early due to student demand. The Cook Campus community primarily targeted SEBS students while the Busch Campus primarily targeted SAS students. The multi-campus community was discontinued.

2010-2011, 2011-2012. In 2010 and 2011, the AIMS program was comprised of the same three communities as the 2009-2010 academic year: the Busch Campus Residential community, Cook Campus Residential community, and the Commuter community.

Common Residential Experience

The residential participants of the AIMS learning communities lived together in the same on campus residence hall. The School of Arts and Sciences (SAS) students were mostly placed in Metzger Hall on the Busch Campus while the School of Environmental and Biological Sciences (SEBS) students were mostly placed in Perry Hall on the Cook Campus. Any student request to live on a different campus was accommodated based on space. The one credit Careers in the Sciences FIGS, the expository writing, and mathematics courses were taught on the respective campuses.

2008-2009. During the first year of the program there was only one residential AIMS community and it was located on the Busch Campus in Davidson Hall.

2009-2010. In 2009, the Cook Campus Residential community was added to the pre-existing Busch Campus Residential community, which was re-located to Metzger Hall.

2010-2011, 2011-2012. The residential communities were the same as the previous year with the Busch and Cook Campus Residential communities.

Mentor Up - Peer Mentors

The Mentor-Up program was initially separate from the learning communities. The program was originally intended to provide a larger subset of the incoming STEM students with a peer mentor. However, based on available staffing, concentrating the peer mentor support to the learning community students was a more practical approach to providing support. The addition of peer mentors to the communities provided students with an additional level of support. They built a stronger sense of community and allowed for the addition of more interventions like monthly programming. Peer mentors were not an original AIMS component, therefore non-residential peer mentors were utilized during the first year and residential peer mentors were added in the second year of the program.

An AIMS peer mentor (PM) is a successful undergraduate STEM student who can provide their mentees with a personal orientation to Rutgers. They assist with the transition to the college life, adapting to Rutgers, shed insight on the rigors of STEM courses, navigating available resources, and create a supportive peer group among students. The PMs are responsible for organizing programming, facilitating informal study sessions, holding monthly meetings, and serving as role models. During the course of the grant, the recruitment and training of AIMS PMs changed significantly.

2008-2009. In 2008, faculty and program directors were contacted to nominate qualified undergraduate students for the PM position. Students were required to submit applications with their GPA and a short essay explaining why they wanted to become a peer mentor. A GPA cutoff of 3.0 was used to screen applicants. 35 qualified applicants were interviewed and 18 were selected. The PM's were then matched to incoming AIMS students with a mentor-match form listing their likes and dislikes. There were no in-hall residential PMs due to the start of the grant, therefore, all AIMS students were assigned to a non-residential PM. PM training was also impacted by the start of the grant. In lieu of summer training, mentors attended monthly "Mentor-to-Mentor" meetings that concentrated on introducing mentoring skills like active listening and learning styles. PMs and mentees were introduced during a "Meet your Mentor" reception held in late September. PMs submitted monthly logs with details regarding their communication with their mentees. PMs indicated that they enjoyed having a structured activity to attend with their mentees.

2009-2010. In 2009, the peer mentor program was redesigned to provide the residential learning communities with two undergraduate peer mentors that lived in the community to serve as mentors and develop programming. Non-residential PMs were assigned 3-5 mentees and were expected to meet with them at least once per month. The non-residential PMs were also expected to collaborate with each other to develop programs for all AIMS students and PMs.

Overall, PM recruitment was much more comprehensive. Advertisements were placed in the campus newspaper, on student life listservs, through STEM focused student groups, the SAS Honors program, School of Engineering, and SEBS. Faculty and program directors were once again asked to nominate and encourage their best students to apply. Classes with large sophomore STEM populations, like Organic Chemistry, were targeted for recruitment. In addition, PMs were recruited from the program's 2008 cohort. Eight residential mentors and 22 non-residential mentors PMs were selected from an applicant pool of 55. The PM application process included an application, minimum GPA of 3.0, group (for residential only) and individual interviews, a recommendation, and an essay detailing why they wanted to become a PM, their involvement at Rutgers, and why they feel they would make a good PM. Four residential PMs were assigned to the AIMS communities while the other four were assigned to two other RU-STEP learning communities.

Similar to recruitment, PM training was modified significantly. Their extensive training began with three days over the course of the spring and was completed with a three-day training in the last week of August. Training included team building, listening exercises, typical first-year stressors and adjustment issues, first-year needs by month, peer mentoring scenarios, information on advising sessions, resources available at Rutgers, program planning guidelines, fall program planning, communication skills, a detailed overview of the mentee Orientation, planning for the community Kick-Off event, and a review of job responsibilities. PMs received a binder with all training materials.

PMs and mentees were introduced to each other during the Orientation prior to school starting. The community Kick-Off Event occurred on the first Friday of the fall semester and included structured activities for the PMs and the students to participate in together. PMs completed monthly tracking forms to document their interactions with their mentees, which they submitted to their supervisor, and attended 90-minute monthly mentor meetings

2010-2011. In 2010, peer mentor recruitment and training began in the spring 2010 semester and remained essentially the same as the previous year with some additional efforts. Solicitations were made to previous and active peer mentors. Nomination requests were also sent to campus programs with target populations like the Educational Opportunity Fund (EOF), Douglas Project for Rutgers Women in Math and Science, Office for Diversity and Success in the Sciences (ODASIS), and faculty with many research students. The application process was the same as the previous year with an application, minimum GPA of 3.0, essay, group interview (for residential only), individual interview, and recommendation. Eight residential peer mentors and 14 non-residential peer mentors were chosen from over 60 applicants. There were two residential peer mentors for each living-learning community and non-residential peer mentors were assigned three to five mentees. The timing of the Orientation and the Kick-Off event remained the same. PMs were required to submit the same monthly tracking forms detailing their interactions with their mentees, however they worked closely with the graduate advisor who facilitated supervision and professional development. An increasing number of participating peer mentors were recruited from the learning communities from previous years, which created a strong sense of community among them.

2011-2012. In 2011, the recruitment, application, and training for the PMs were the same as the previous year. Mentors were given extensive training in the spring and summer to prepare them for their responsibilities. Each of the residential communities employed two PMs who lived on the residence hall floor with the learning community students. The commuter community employed several PMs assigned to three to five students. The PMs were more involved in programming, assisting with the events planned by their graduate advisor. They continued to submit monthly tracking forms and work closely with the graduate advisor. Many of the 2010-2011 PMs re-applied and were re-hired for the position. Similarly, previous learning community students filled some of the remaining positions.

Programming

The STEM-based programming within the learning communities focused on academic and professional success and had two goals. The first was to increase student awareness of possible career opportunities in the sciences. The second was to provide students with the key transition components to assist with navigating Rutgers and its resources. The learning communities commenced with an intensive AIMS Orientation for all students and an early move-in program for residential students. One of the major goals of the programming was to increase awareness of careers in the sciences. In addition, students were offered structured activities throughout the year which included: exclusive academic advising sessions with first-year Deans, meetings and social events with peer mentors in STEM majors, science demonstrations run by faculty, and programming facilitated by the AIMS PMs. Each of the residential learning communities were given a small budget to offer students the opportunity to participate in academic and social activities designed to expose them to various aspects of STEM. PMs were responsible for assessing student interest and then planning and facilitating the programs. The commuter PMs were instructed to gauge student interest and then accompany mentees to available programming on campus that met their needs and interests. The program concluded with the annual "New Beginnings Ceremony." The ceremony incorporated a range of speakers including AIMS students and first-year deans. Nominations for outstanding PMs and AIMS students were made prior to the event and they were a recognized for their exceptionally hard work during the reception.

2008-2009. In 2008, there were no residential PM's and the programming primarily occurred through the FIGS course. As per the Final Activities Report for 2009, the number of programs implemented in the first year, 2008, was limited by the start date of the program.

2009-2010. In 2009, AIMS programming increased significantly. The fall semester programming started with the Fall Meet and Greet where mentors met with their mentees in a more social setting. Residential Peer Mentors were required to develop four programs each semester. They gauged student interest and then developed and facilitated applicable programming. The programs had either a scientific or academic focus, but often targeted study skills and academic performance. Similarly, commuter Peer Mentors were required to work together to develop and implement one program per semester for the commuter students. The spring semester started with the "Physics of Bowling" program in January and concluded with the "Great Beginnings" end of year celebration in May. To assist with program development, PMs were assigned an RU-STEP staff member to meet with regularly.

2010-2011. In 2010, the RU-STEP wide activities like the Fall Meet and Greet, Physics of Bowling, and the Great Beginnings ceremony were continued. All other programming and activities were primarily planned and executed by the residential peer mentors, with guidance from the graduate mentor. Similar to the previous year, programming focused on the development of academic skills. Non-residential peer mentors were required to plan one large-scale program and accompany each of their mentees to one program per semester.

2011-2012. There were no changes made to peer mentor expectations in terms of residential programming and graduate advisor support. It was conducted identically to the previous year. However, some of the programming shifted from science interest-based to an emphasis on study skills, time management, and math anxiety. The commuter PMs were required work with their graduate advisor to plan a large-scale program and were also required to accompany each of their mentees to one program each semester. The RU-STEP wide annual activities like the Fall Meet and Greet, Physics of Bowling, and the Great Beginnings ceremony were continued.

In addition, the graduate advisors for three of RU-STEP learning communities developed and hosted RU-STEP wide programs each semester to build a larger community with a greater support network. The graduate advisors planned one program a semester, which drew upon their experiences and work in their own doctoral programs. The following programs were hosted: 1) Anatomy Orientation at Robert Wood Johnson Medical School, 2) Academic Integrity in the Sciences, 3) Medical School 101, 4) Martial Arts, 5) Networking Seminar, and 6) a Trip to the American Museum of Natural History.

Academic Success Strategies

In addition to the peer mentor programming, the RU-STEP team hosted several events throughout the year to provide students with strategies for academic success

2008-2009. None

2009-2010. In fall 2009, the Study Smarter Not Harder – How to Study More Effectively program, two writing workshops, and an Academic Advising session were held. An Academic Planning Strategy Session was held in the spring to prepare students for the next academic year.

2010-2011. In fall 2010, Study Smarter, Not Harder was held again as well as the Academic Advising session in the fall and the Academic Planning Session in the spring. The writing workshops were not continued.

2011-2012. Only the Academic Advising in the fall and the Academic Planning Session in the Spring were held.

Tutoring

2008-2009. In 2008, the Learning Resource Centers assisted with providing tutors for exclusive sessions in the residence halls. Mathematics tutoring was offered in the residence halls.

2009-2010. In 2009, there was an increase in the mathematics tutoring offered in the residence halls.

2010-2011. In 2010, the program expanded the available tutoring, added Chemistry tutoring, and offered a one-credit add-on course using ALEKS, the on-line mathematics tutorial program for intermediate algebra and pre-calculus.

2011-2012. Tutors continued to hold exclusive sessions in the residence halls. The tutoring schedule was revised and increased to reflect student need, schedules, and availability. The one-credit add-on course using ALEKS was offered again.

Graduate Advisor

2008-2009. None

2009-2010. None

2010-2011. In summer 2010, a graduate advisor was employed to assist with program coordination and peer mentor supervision. The graduate advisor was responsible for student recruitment, peer mentor training and supervision, and student advising. They worked collaboratively with another RU-STEP graduate mentor, affiliated professors, and residence life staff. The graduate advisor held office hours once a week in each residence hall, met twice a month with each pair of residential peer mentors, and monthly with each individual peer mentor to provide guidance. The graduate advisor also provided the first-year AIMS students with a graduate role model.

2011-2012. In 2011, the early alert process was added to the responsibilities of the graduate mentor. In addition to the weekly 2-hour office hours held in each of the residence halls, the graduate mentor held additional office hours making herself available to all AIMS students in the Math and Science Learning Center (MSLC) located in the Allison Road Classroom building on the Busch Campus. The graduate mentor was also responsible for working with non-residential peer mentors to plan and facilitate one program per semester.

Early Alert Process

2011-2012. In 2011, an early alert process was created to specifically improve mathematics performance through increased advising. The RU-STEPed Up for Success Program in collaboration with Dr. Lew Hirsch, the mathematics faculty director, developed the Early Alert notification process to provide additional interventions for AIMS students to further support them in their math courses. The early warning system identified struggling students earlier than the Rutgers Warning system and provided appropriate interventions to ensure success in their math course.

Math professors instructing AIMS sections were contacted in September introducing the early alert process. They were provided with a list of AIMS students registered for their classes and instructed to submit their syllabi to the Graduate Advisor of the community. They were also asked to start identifying students who were academically struggling based on their performance and to complete a brief online Progress Report for each struggling student by October 3, 2012. (Progress Report Link: http://rulc.rutgers.edu/content/progress-reports)

The Graduate Advisor compiled the progress reports and students were contacted via e-mail. Students were informed that the AIMS program was collaborating with their math instructor to track their academic progress in their current math course and their professor indicated that they would benefit from available resources to ensure greater success. Students were required to complete the AIMS student Information Form prior to meeting with the Graduate Advisor to provide supplemental information. (AIMS Student Information Form Link: https://www.surveymonkey.com/s/W3LHVQK)

A follow-up e-mail was sent to each student after their meeting summarizing the most appropriate recommendations for academic success based on the conversation, teacher input, and information provided by the student. Recommendations included referrals for tutoring, academic coaching, professor/TA office hours, and meeting with their Dean. The Graduate Advisor worked with a representative from the Learning Resource Center who contacted all students referred for Academic Coaching to schedule an appointment.

In the Spring semester, student GPAs were analyzed and at-risk students were contacted regarding their academic performance. Students with a GPA below 2.0 were on Academic Warning by University Policy. They were reminded to schedule their mandatory appointment with an academic advisor between February 13th and February 20th to review academic progress and register for appropriate courses. Students with a GPA between 2.0 and 2.5, although not on Academic Warning, were strongly urged to schedule an appointment with a dean to discuss their progress for the current semester prior to the March 19th deadline to drop a class. During the course of the spring semester students who received academic warnings in various subjects were contacted and encouraged to speak with their Graduate Advisor to discuss options if they were still enrolled in the course.

Appendix F

Literature Review

The purpose of this study is to provide an evaluation of the Achievement in Math and Science (AIMS) learning communities at Rutgers University (RU). This section surveys the pertinent research regarding the national crisis, contributing factors, evidence-based learning community components, and outcomes. First, background information on the nation's economic history and current status is provided to establish the rationale for the existence of STEM-based learning communities. Second, an overview of evidence-based interventions and retention programs are examined. This is followed by a discussion of contributing components like the first-year experience, first-year seminar and linked courses, academic preparation and college readiness, math and the impact of remediation, and residence life. Learning community models and supporting literature incorporating the aforementioned components are outlined. A detailed description of the AIMS learning communities at RU and the changes made to recruitment practices and implemented interventions by academic year can be found in Appendix E.

Economic Crisis

The United States has historically been one of the world's leading nations in technological development and advancement. Progress made in the early 20th century helped to establish the nation's technological evolution in relation to the rest of the world resulting in economic and political leadership. The high quality of education, specifically in the areas of mathematics and science, produced a scientifically literate workforce with strong skills capable of innovative research. It was this science-based progress that fueled the American economy by creating jobs and raising the standard of living (Johnson, 2012). However, in recent decades, the educational standards, innovation, and global activity of other nations have improved significantly while that of the United States has declined, gradually closing the gap on the lead once held (Johnson, 2012). Leaders across STEM disciplines refer to "the steady erosion of America's scientific and engineering base," (Friedman, 2005, p. 253) as a "quiet crisis" (Reid, 2009, p.5), comprised of three integral components: the decline in STEM interest, the anticipated retirement of the current STEM workforce, and the projected job growth within STEM fields (National Science Board, 2003). The National Science Board (NSB), the governing body of the National Science Foundation (NSF), made projections regarding the current situation by analyzing the U.S. science and engineering trends (NSB, 2003). In their report, *The Science and Engineering Workforce: Realizing America's Potential*, they accurately identified and projected the following problems: reduced student interest in STEM disciplines, increased retirement within the STEM workforce over the next two decades, a rapid growth in STEM occupations resulting in an increase in the need for workers with STEM skills, and pressure on state and local budgets for STEM education.

In 2010, The United States Census documented the nation's overall college graduation rates among working adults and found that it was only 40%, of which, approximately 30% had a bachelor's degree and 10% an associate's degree (Carey, 2010). In response to this quiet crisis, President Obama announced his plan "to retake the international lead in college graduation by 2020" (Johnson, 2012). More specifically, contributing to the nation's low graduation rate, is the lack of interest in STEM fields, which has led to a decrease in the number of earned STEM degrees. This shortage of interested, skilled and trained professionals within the United States, has compelled us to outsource higher-skilled work to other nations, further supporting their economic prosperity rather than our own (Johnson, 2012).

In addition to the nation's deteriorating commercial crisis, there is a shortage of healthcare professionals. The National Intelligence Council (2008) attributes the increase in the need for STEM workers to the recent technological evolution, global competition, and the increasing number of aging baby boomers in need of health care services. Due to the lack of students in health-related programs the nation will not have the ability to meet the health care needs of its population (National Intelligence Council, 2008).

Over the next two decades, America's current STEM workforce will quickly approach retirement age and with the lack of pursued STEM degrees the positions will remain vacant and innovative activity will continue to decline further. In 2007, The U.S. Bureau of Labor Statistics reported that occupations in STEM were expected to grow by 22% between 2004 and 2014 whereas the job growth for all other occupations was estimated to be 13%. In their 2010 report, *Help Wanted: Projections of Jobs and Education Requirements through 2018,* Carnevale, Smith, and Strohl (2010), projected an increase in STEM positions from 7.3 million to 8.6 million by 2018. Additionally, the field is forecast to provide 2.8 million job openings with 1.2 million created from new jobs and 1.6 million from replacement openings (Carnevale et al., 2010). The projected STEM openings by education requirement indicated that the highest demand would be for workers with Bachelor's degrees, followed by those with Master's degrees or better (Carnevale et al., 2010). 92% of all professional STEM positions will require postsecondary education by 2018 (President's Council of Advisors on Science and Technology, 2012). STEM education is an investment in our nation's future and only by matching the projected job growth with a commensurate number of successful students will we ensure our nation's ability to evolve economically. The NSF (2010) identified successful students as leading STEM professionals with the ability to develop cutting edge scientific and technological breakthroughs. STEM students with strong academic performance are more inclined to strive towards academic and career aspirations within STEM fields, ultimately leading to their professional contribution to the economic growth of our country (Johnson, 2012).

While the demand for skilled professionals has increased tremendously, the degrees awarded in STEM fields have decreased (Thiel et al., 2008). With respect to the numbers of students seeking STEM degrees, the upcoming retirement of the current workforce and the projected vacancies in the field we, as a nation, should be very concerned with “who will do the science?” (Jackson, 2004). In an effort to appropriately address the crisis at hand it is crucial to focus our efforts where we can be most influential. The retirement of STEM workers is inevitable. Regardless of ability, development, and motivation to work, due to age our current STEM workforce will be unable to fulfill the requirements of their position. Attempting to inhibit the growth of America’s STEM occupations would only hinder the nation’s economy and position as an innovative leader. Therefore, developing interest in untapped intellectual talent would prove to be the most prolific approach to changing the question from “who will do the science?” to “who wants to do the science?” (Jackson, 2004). The challenge in sustaining the STEM workforce of the future is no longer about providing access and opportunity but developing interest and talent of all children, specifically within women and minorities who, according to data, continue to be significantly under-represented (Reid, 2009).

Colleges and universities across the nation are now responsible for our country’s economic prosperity. They must recruit, retain, and graduate more students, who are expected to have strong STEM skills, literacy, and training, enabling them to contribute to the STEM workforce. Graduation rates have become an increasingly important measure of institutional success (Goenner & Snaith, 2004) and universities are now being held accountable for these educational outcomes as well as the preparation for employment after graduation (Johnson, 2012). Unfortunately, U.S. universities are not producing STEM workers at an adequate rate to address the nation's problem of declining innovation-based competitiveness (Atkinson & Mayo, 2010).

In addition to the expected quantity and quality of STEM students they are expected to prepare, institutions are also faced with the task of remediation due to the quality of education of incoming students. The report *A Nation at Risk*: *The Imperative for Educational Reform* (The National Commission on Excellence in Education (NCEE), 1983) exposed the truth about the American education system and the inadequate academic preparation provided prior to college enrollment causing a rise in the need for remedial courses at higher education institutions. The NCEE (1983) found that students in competing industrialized nations were spending three times more time in math, science, and geography than our most science oriented student. More recent studies have emphasized the United States' poor performance in STEM education as indicated by student achievement (Lander & Gates, 2010).

Consequently, colleges and universities have become more cognizant, emphasizing the identification and modification of institutional factors to be more accommodating to the needs of their students. Institutional factors like major field, percentage of first-year students residing on campus, and institutional size are associated with retention rates (Astin, 1997). Institutions with more students in business, psychology and other social sciences had higher retention rates than those with more students in engineering. Institutions with higher percentages of first-year students living in residence halls also had higher retention rates. However, the size of the institution had a negative effect on retention making retention rates for smaller institutions higher than larger institutions. The identification of institutional factors and program elements highly correlated with student progress in STEM disciplines are providing institutions with the information needed to develop targeted interventions.

Legislature and National Efforts

Federal programs, legislation, and policymaking have focused on efforts to eradicate the educational inequality for women and minorities helping them to attain STEM education at the post-secondary level (U.S. Department of Education/NCES, 2000). Title VI of the Civil Rights Act of 1964 is comprised of eleven titles protecting the constitutional right to any program or activity receiving federal funding while prohibiting discrimination on the basis of race, color, and national origin (U.S. Department of Justice, 2013). Title IX of the Education Amendments Act of 1972 forbids discrimination on the basis of sex and the Women's Educational Equity Act of 1974 funded projects to improve the quality and scope of education for women (US Department of Education/NCES, 2000**).**

In other areas, millions of dollars have been allocated to fund programs and interventions. "The National Science Foundation (NSF) human resource programs were designed to assure equality in science and engineering education. In addition, higher education institutions, both public and private, have been recruiting and providing programming and support for women and minorities to study in technical fields traditionally dominated by white men. Also, various K-12 strategies have been developed and implemented to improve math and science education for girls and underrepresented minorities" (Reid, 2009, p.17). Despite the legislative acts and combined national efforts to ensure equity, access, and opportunity in education and employment, attrition and enrollment data indicates persistent and continuous underrepresentation of women and minorities in science-related disciplines (U.S. Department of Education/NCES, 2000; Jones 1997).

Evidence-Based Intervention and Retention Programs

There are four common program models, which often overlap, to provide undergraduate women and underrepresented minorities with career development opportunities (Reid, 2009). The first are retention programs that are specifically designed to help underrepresented undergraduates in the sciences graduate. The second are career promotion programs, which recruit high school students into college as well as undergraduates into graduate school and STEM careers. The third are referred to as research apprenticeships that provide advanced undergraduates with mentored opportunities. The last are research-based learning programs that integrate hands on research-like experiences into the classroom environment.

The research has identified three general characteristics evident in successful retention programs; the most noteworthy interventions begin with the admissions process, involve a breadth of institutional components, and are often longitudinal in nature (Tinto, 1993). Subsequent research identified more detailed characteristics common to STEM intervention programs that were successful in meeting their programmatic goals. Findings pertained to student recruitment and participation, external support, and specific elements of the program. Students were recruited specifically from diverse racial/ethnic groups and were empowered to take an active role in the development and facilitation of program activities (Matyas, 1992). External program support was integral to program success and effectiveness. University faculty and administration across the campus were actively involved in collaborative efforts and provided group mentoring, served on advisory boards, supervised laboratory visits, and made research opportunities available for program participants (Matyas, 1992). The program also included outreach to the parents of participating students and prioritized follow-up with students, faculty, and parents (Matyas, 1992). In reference to program elements, all strategies were evidence based and equally important, the goals identified were clearly defined, and a goal-driven program evaluation measuring effectiveness was developed prior to implementation (Matyas, 1992). The program provided students with consistent involvement throughout their undergraduate career, intensive academic supports, frequent contact with program staff (daily or weekly), supportive peer networks, little or no fees for involvement (or resources for available financial aid), opportunities for laboratory research, wellness check-ins, peer study groups, residential experiences like overnights, bridge programs, and summer programs where applicable, and the involvement of and access to academic and career role models (Matyas, 1992). There is an emphasis on the necessity and use of an assessment to measure program effectiveness (Tinto, 1999). Program evaluation is crucial to program enhancement, but is often inadequate to accurately measure effectiveness (Dennis, Phinney, & Chuateco, 2005; Taylor & Miller, 2002).

A Building Engineering and Science Talent (BEST) study (Best, 2004) conducted a comprehensive nationwide review of existing STEM programs to identify the higher education practices responsible for the improvement of retention among underrepresented students in STEM disciplines. They found that the most effective strategies were encompassed in Matyas' (1992) program elements and included: the involvement of accessible faculty, the availability of mentoring and tutoring, peer support networks, and enriching research experiences. Further supporting the BEST (2004) findings, the literature on retention programs found academic assistance, social connection, and transition to the campus culture to be important institutional factors that contributed to easy transition and retention (Gardener et al., 2001; Braxton et al., 2007; Walker & Schultz, 2001). Similarly, research on academic and social integration found advising and counseling, mentoring, bridge programs, peer network groups, and active engagement in learning to be supportive of STEM degree completion (Tinto, 1993; 2004).

The Hawk Link Retention Program at the University of Kansas was created to ease the transition to the campus climate. This comprehensive retention program had the following variables: academic skills training, career planning, cross-cultural awareness events, leadership development, peer mentoring, personal counseling, early academic progress/warning monitoring, frequent meetings, a freshman seminar course, group study sessions, a "home base" environment, proactive and intrusive advising, time management workshops, and tutoring (Clounch, 2010). In 2003, Hawk Link produced a first-year retention rate of 84% (Clounch, 2010) while the overall university retention rate was 82% (Office of Institutional Research and Practice, 2006).

Program success has been evaluated by measuring a wide range of outcomes and is highly dependent on the identified program goals. In 1990, Kremer and Bringle determined the long-term success of their Undergraduate Research Program (URE) by examining the percentage of their participants that subsequently pursued graduate STEM degrees, the amount of conference presentations and publications, and qualitative data capturing positive participant experiences. One of the universal benefits and outcomes expected of program participation is greater academic achievement. However, the literature is somewhat divided in its determination of which measures indicate improved academic success (Kahrig, 2005). Grade-point averages (GPA) have been more popular among researchers, but academic standing has proven to be a credible contender. Researchers utilizing GPA to demonstrate program effectiveness report the difference between the GPAs of program participants and their non-participating peers, attributing the difference to the intervention (Kahrig, 2005). Studies have indicated that student

GPAs are typically examined at the end of the first semester or cumulatively at the conclusion of their first year. A student's academic standing is determined by their GPA. Despite the correlation, researchers have found academic standing to be a more useful performance indicator than GPA. Research conducted by Soldner, Lee, and Duby (1999) claimed that the GPAs earned by their First Year Experience (FYE) program participants were similar to that of their non-participating peers. Conversely, they found a statistically significant difference between the percentage of participating and non-participating students on probation. Only 22% of their participants were on academic probation after the completion of their first semester, while 33% of nonparticipants were on probation (Soldner et al., 1999).

First-Year Experience

The need for an intervention addressing undergraduate success in STEM is evident, however, it is vital to identify the most appropriate time for institutions to introduce and apply their limited resources. Overall retention rates have been a cause for concern. Freshmen attrition rates are higher than ever, ranging from 20% to 30% (Johnson, 2012). In general, an estimated 40% of undergraduate students do not graduate with a degree and 75% of them leave within the first two years (Johnson, 2012). The statistics involving STEM fields are equally concerning. Less than 50% of students intending to pursue STEM fields graduate with a STEM degree and more than 30% leave specifically between freshmen and sophomore year (Business Higher Education Forum, 2011). In terms of students' potential for academic success, early intervention can make a positive impact, and this is particularly true for minority and female students (Gilmer, 2007).

The primary predictor of student success in their major, college graduation, and graduate school admissions is an academically successful first-year (The National Center for Education

Statistics, 2009). In a study of college students divided by year, it was determined that the longer a student was enrolled in an institution the more factors accumulated to influence their academic decisions (Bean & Metzner, 1985). Therefore, interventions targeting first-year students, who have limited higher education experiences, would prove more effective and provide more academically favorable factors. It is the responsibility of the institution to academically and socially integrate their first-year students through programs and services (Johnson, 2012) because "involvement matters, especially during the first year of college when student attachment to the communities of the campus is so tenuous" (Tinto, 1999, p.3). The positive impact of first-year interventions, like seminars and learning community participation, on freshman to sophomore year retention have been substantiated and documented throughout the empirical literature (Barefoot 1993, 2000; Barefoot, Warnock, Dickinson, Richardson, & Roberts, 1998).

First-Year Seminar and Linked Courses

First-year seminar courses have become increasingly popular. There has been a recent influx of scholarly literature supporting their positive influence on retention and academic success (Barefoot et al., 1998). Higher education leaders have designed first-year seminars as well as learning communities using an active learning approach as the foundation (Tinto, 2010). Therefore, these small seminars have the potential to stimulate intellectual growth through the use of inquiry based learning in a collaborative environment (Boyer Commission Report, 1998). Examples include cooperative learning and problem-based learning methodologies.

Learning communities with a first-year seminar component were found to have higher retention and graduation rates because students are given the opportunity to form peer study groups, which then contributes positively to their comprehension of class material across disciplines (Barefoot et al 1998; Tobolowsky, Cox, & Wagner, 2005). Active engagement methodologies in first-year seminars have been more successful when linked directly to course content (Tinto, 2010), and is made possible by employing the learning community model that Gabelnick, MacGregor, Mathews and Smith (1990) and Smith (1991) refer to as linked courses. The linked courses model requires the learning community cohort to co-register for at least two paired content courses in addition to the first-year seminar (Gabelnick et al., 1990). This model is typically focused on a pre-major topic like Careers in the Sciences, in which the first-year seminar includes orientation activities, fosters the formation of study groups for content courses (Smith, 1991), and explores careers in the sciences to generate interest. During a presentation at the Retention 360 Conference held in Cincinnati, Ohio, on November 10, 2010, Tinto supported and advocated for the use of this particular model. The linked course learning community model with the first-year seminar is the most utilized model by larger four-year institutions because it does not require significant changes to the established curriculum (Lucas & Mott, 1996).

More importantly than the approach to learning and in addition to increased retention are the student perceptions regarding their participation in a learning community and first-year seminar. Learning community students report "higher levels of academic effort, academic integration, and active and collaborative learning" (Zhao & Kuh, 2004, p.124). When looking at the effects on student engagement, students who participated in first-year seminars: "(a) were more challenged academically, (b) reported more active and collaborative learning activities, (c) interacted more frequently with faculty, (d) perceived the campus environment as being more supportive, (e) reported that they gained more from their first year of college, and (f) were more satisfied with the college experience (NSSE, 2005, p.15)." Students are leaving institutions specifically because they lack these experiences, therefore institutions readily providing their students with this level of academic support will have higher rates of retention. For the purposes of this research, the first-year seminar will be referred to as the First Year Interest Group Seminar (FIGS).

Academic Preparation and College Readiness

The effects of academic preparation and college readiness are often underestimated and have various influences. ACT (2011), defines college readiness "as the acquisition of the knowledge and skills a student needs to enroll and succeed in credit-bearing first-year courses at a postsecondary institution without the need for remediation." Students who are well prepared for college level coursework are more likely to experience academic success and thus stay in school (Johnson, 2012). A study on institutional success determined that students attending more selective institutions not only met performance expectations, they exceeded them (Blose, 1999). The more selective institutions had better prepared students and so they had higher graduation rates while the opposite was true of less selective institutions (Blose, 1999).

In a 1997 study, Seymour and Hewitt found that the STEM grades of students who left the sciences were comparable to those that persisted, indicating ability was not an influential factor in their decision. More prevalent than intrinsic individual ability were environmental factors like the lack of K-12 preparation for the rigor of STEM education, the social novelty associated with entering college, and the university's inability to support students academically and socially during their transition (Johnson, 2012). In contrast, Civian and Schley (1996), in their study of college women, found that those who left STEM programs had slightly lower grades and SAT scores, but interestingly, were less likely to have a parent with an advanced degree.

Ben Ost, a Cornell economics Ph.D. student, presented on differential grading at the 2010 conference, "Analyzing the Factors That Influence Persistence Rates in STEM Field Majors." Ost (2010) argued that a gap existed between the grading of science and non-science courses and that students, even those majoring in STEM, earned higher grades in non-science courses. Persistence is influenced by outcomes and academic outcomes are grades, therefore students gravitate towards the areas in which they experience the most success. This grading gap "pushes" discouraged students away from science courses and "pulls" them towards non-science disciplines (Lowery, 2010; Ost, 2010). Students who are better prepared, academically, for the rigors of STEM courses will not only earn higher grades in those subject areas but also persist within the field.

The opportunity to demonstrate achievement despite the demands of STEM-based courses occurs as early as the first semester. All students pursuing STEM disciplines must successfully complete a series of science prerequisites before they are able to register for higher-level courses within their program. These rigorous classes are assigned early in their collegiate career and are a part of the "weeding out" process that demonstrates the student's ability to progress in the subject area. The level of academic preparation prior to college determines the expected level of achievement in these difficult prerequisite courses. According to the NSF, a disproportionate number of students make early conclusions regarding the excessive difficulty of STEM subjects (Johnson, 2012) based on the level of difficulty of prerequisite courses.

Tobias (1990) referred to students partaking in the weeding out process as "second tier" (p.53). They are specifically defined as students with both the intention and ability to succeed, but experience a failure in an introductory science course and are then pushed away from science and pulled towards a nonscientific field (Tobias, 1990). In her study on student outcomes in introductory science courses, Tobias, (1990) focused on the course features responsible for driving away second tier students and findings supported Tinto's (1997, 2010) argument regarding the achievement of social integration through classroom experience. Tobias consistently found the following negative features in introductory science courses: (a) failure to motivate student interest in science by establishing its relevance in their lives and interests, (b) almost complete student passivity in the classroom, (c) emphasis on competition for grades rather than cooperative learning with their peers, and (d) focus on analytical problem solving as opposed to conceptual and practical understanding. Poor learning experiences are the primary reason undergraduates switch out of STEM disciplines (Seymour & Hewitt, 1997).

Socioeconomic status and income disparities were also found to have an impact on the academic outcomes, academic preparation, and personal goals of students as it determines the availability of resources (Johnson, 2012). Tinto (2010) introduced the development of basic-skills learning communities, to help bridge the gap between previously acquired skills and prevailing required skills. This model is commonly utilized by institutions that make accommodations for students who lack the academic foundation and skills required to pursue health-related fields (Whalen, 2012). As it pertains to the undergraduate pursuit of STEM majors, advanced classes in math and science were found to be critical to arriving prepared (Fear-Fenn & Kaptosy, 1992). Tinto (2010) hoped to achieve this subsequently through the use of integrated support within the classroom, the use of supplemental instruction, and accelerated learning techniques within the learning community. A student engagement theory developed by Kuh, Gruce, Shoup, Kinzie, and Gonyea (2008) supported the use of calculated educational activities during the first year of college to increase academic engagement and enhance learning experiences. Using the National Survey of Student Engagement, they collected a sample of over

6,000 students and analyzed the data from 18 different universities. Kuh and associates (2008) found student engagement was not only positively correlated to academic outcomes and persistence, but had a compensatory effect. Students were able to compensate for academic and socio-economic disadvantages through increased engagement. Students are completing high school and entering college without the appropriate study skills, however those with disciplined and systematic study habits are able to compensate for their academic shortcomings with increased effort and academic support (NCEE, 1983).

Despite the job prospects associated with STEM, students intending to pursue these careers are prevented from joining the STEM workforce. Due to the rigor of prerequisite courses, their significance to the student's academic career, and the lack of academic preparation, it is important for educational institutions to provide adequate academic support, ensuring both student success and retention (Whalen, 2012). An increase in the retention of undergraduates in prerequisite STEM courses prevents early attrition, which leads to increased undergraduate graduation in STEM, ultimately affecting the enrollment of students in STEM graduate programs and the production of competent and influential STEM professionals.

Math Achievement and Remediation

Mathematics courses are the gateway to STEM majors and science literacy due to the high correlation between mathematics and science achievement (Li, Shavelson, Kupermintz, & Ruiz-Primo, 2002). Math proficiency is integral and often an obstacle to early academic achievement for undergraduates (Thiel et al., 2008). In a study on the college readiness of the high school class of 2011 across the United States, only 45% of graduates met the college readiness benchmark in math however, an additional 9% were within two scale points (ACT, 2011).

Math proficiency has been a focus of research for quite some time. Three decades ago, the National Commission on Excellence in Education found that remedial math courses in public 4-year institutions were increasing and between 1975 and 1980 they increased by 72 percent, constituting 25% of all mathematics courses (NCEE, 1983). More recently, according to the 2005 report, *A Commitment to America's Future: Responding to the Crisis in Mathematics & Science Education*, as many as 22% of college freshmen are required to take remedial math courses to improve their skills before they can enroll in a college-level mathematics class that fulfills the quantitative skills requirement of the institution (Business Higher Education Forum, 2005). Algebra, in particular, has proven problematic as the prerequisite to Calculus, which, is the most basic level of math for students interested in pursuing programs that ultimately lead to advanced degrees in the sciences (Thiel et al., 2008). The literature identifying college algebra as an obstacle for undergraduate students also allude to higher prevalence among those in underserved populations (Thiel et al., 2008). Students who completed calculus in high school, prior to college enrollment, have higher rates of STEM intention for their undergraduate course of study than those who did not (National Survey of Student Engagement, 2013).

The interest in STEM majors among college-bound high school seniors is less than one in three. Even more distressing, is that less than one in five are both interested and proficient in mathematics (Business-Higher Education Forum, 2011). Low performing students who begin their undergraduate career in STEM with high interest and ability are then faced with the prospect of poor academic performance in the prerequisite science and mathematics courses resulting in STEM attrition. As the levels of STEM interest continue to decline, and contributing factors like academic preparation, math proficiency, and socioeconomic status are added to the equation, the workforce demand is far from being met.

Residence Life

Universities include many departments designated to develop various aspects of student life. The residence life department is distinctive in their capacity to offer unique educational opportunities, through the use of their facilities, staff, and intentional programming, which integrate the academic and social development of their students (Blimling, 1999; Chickering, 1974; Zheng, Saunders, Shelley, & Whalen, 2002). This breadth of influence, coupled with the percentage of university students who can be targeted, make residence halls the optimal place to provide resources (Winston & Anchors, 1993). However, they often fail to reach their full potential (Pascarella, Terenzini, & Blimling, 1994). Residence halls have been identified as a predictor of STEM graduation. First-year residential students with a declared STEM major are 2.2 times more likely to be successful than first-year commuter students (Johnson, 2012). The level of academic and social integration they experience as residential students provide an academically enriching atmosphere, which cannot compare to the experience of a commuter student.

The literature on university retention indicates that academic and social integration exerts the most influence on persistence and achievement (Pascarella & Terenzini, 1991). According to Pascarella and Chapman (1983) social attachment had a stronger influence on persistence at four-year primarily residential institutions, while academic attachment was more important at two and four year commuter institutions. Interestingly, social integration exerted more influence on the persistence of female students whereas academic integration was more important to male students (Pascarella & Chapman, 1983). Regardless of gender, social and academic integration have proven influential on student persistence. Consequentially, university social policy has focused on strengthening student attachment. Colleges and universities are social systems in which the integration of academic and social components is necessary to prevail (Tinto, 1975). Through the examination and understanding of the integration process and its correlation to attrition and retention, universities can develop and implement purposeful interventions to promote social and academic attachment leading to academic achievement and persistence.

Astin (1999) defined student involvement as “the amount of physical and psychological energy that the student devotes to the academic experience” (p.518). Living on campus was found to positively impact student involvement (Astin, 1993) and involvement was found to have a positive influence on intellectual and emotional development, satisfaction, and persistence (Astin, 1999). In his paper on student persistence, Tinto (1998) found that involvement mattered most during the first year. The interaction between students and faculty was positively correlated with persistence, while social and academic integration influenced persistence, however, in collaboration they had a greater impact on persistence (Tinto, 1998). The effects of social and academic integration varied between two-year and four-year institutions (Tinto, 1998).

The first-year experience in particular is enriched by on campus living. Programming and services provided by residence life staff encourages early involvement of students in social communities increasing the likelihood of retention through confidence building and social integration (Hotchkiss, Moore, & Pitts, 2006). Residential students specifically in their freshmen and sophomore years were found to have increased self-confidence (Astin, 1999) reporting higher positive self-ratings on academic confidence, public speaking and leadership skills (Chickering, 1974). As a result they are 12% more likely to complete their undergraduate degree (Ballou, Reavill, & Schultz (1995).

Students living in residence halls on campus also experience more academic success than those commuting to campus (Blimling, 1999 & Chickering, 1974). They have higher persistence and graduation rates (Blimling, 1999; Pascarella & Terenzini 2005), take more credits, and have higher grade point averages than their commuting peers (Chickering, 1974). Even when controlling for precollege variables like socioeconomic status, academic ability, educational aspirations, previous academic performance, age, and employment status the difference remained evident (Chickering, 1974; Pascarella & Terenzini 2005).

Campus-wide involvement opportunities are maximized for residential students. Pascarella and Terenzini (1991) "concluded that it is this involvement that largely accounts for residential living's impact on student change" (p.611). Studies have shown that they have significantly more interaction with faculty and are more likely to be involved in activities with their peers, seek out extracurricular activities, and utilize campus facilities and resources than their commuting peers (Chickering, 1974; Boyer 1987). Due to the development of these relationships and time spent on campus they subsequently reported higher levels of satisfaction with their university and overall experience. In contrast, students attending commuter colleges spend less time on campus and involved in campus activities therefore they have difficulty identifying with the institution, which has a negative impact on retention resulting in higher attrition (Johnson, 2012).

Peer Mentoring

Mentoring occurs in both the professional and academic environment. It is defined as a voluntary and reciprocal interpersonal relationship in which a more experienced, senior individual, contributes to the development of a protégé or mentee by providing psychosocial support, career-related support, and role modeling (Wang, Tomlinson, & Noe, 2010). The relationship is based on trust and mutual respect and is focused on personal and professional growth (Friedman et al., 2004). Peer mentoring at the undergraduate level is similar, but involves a senior student and a first-year student who are closer in age and position. As opposed to traditional mentoring relationships, peer mentors are able to draw from recent experiences and due to the minimal age difference are viewed as more relatable and approachable (Parker, Hall, & Kram, 2008).

There is significantly more research on the mentoring relationships between faculty and students than between undergraduate peers. However, the available literature has shown that mentoring increases the academic achievement, enrollment, and retention of minority students (Kendricks, Nedunuri, & Arment, 2013). Students in mentoring relationships have greater satisfaction with their university, undergraduate experience, and major; and are more apt to participate in extracurricular activities (Holland, Major, & Orvis, 2012). The mentoring relationship is mutually beneficial providing the mentor with a sense of contribution and purpose and the mentee with a sense of professional and academic identity as well as personal competence (Wang et al., 2010).

Mentoring programs can stand alone at academic institutions, but are often embedded within university programs. Effective mentoring programs have key characteristics. The most important of which include a predetermined matching process, the involvement of both career/academic-related and psychosocial mentoring, high mentor commitment, participant understanding of program goals, the quality of mentor training, and mentee satisfaction with the mentoring relationship (P-Sontag, Vappie, & Wanberg, 2007).

The matching process and peer mentor training, in particular, are areas independent of participants and highly dependent on the program planning and preparation. Informal, organically developed, mentoring relationships were prevalent until organizations began to develop formal, structured, mentoring programs to determine who is mentored, when they are mentored, and how they are mentored rather than leaving the mentoring relationship to chance (Baugh & Fagenson-Eland, 2007). An emerging cohesive model is the "structured match," where mentors and mentees are matched based on a detailed profile to increase the likelihood of a successful relationship (Friedman et al., 2004). This deliberate, predetermined matching process is critical to the success of the mentoring relationship (Chao, 2009). It discourages random matching while taking individual differences into account by pairing students based on an academic profile and significant factors like undergraduate major.

Compatibility is a key component however early mentor-mentee interactions are also influential in determining the success of the relationship. Emphasis has been placed on the importance of an orientation phase with introductory experiences as they set the tone for the relationship by providing the opportunity for ice-breakers, collaborative goal-setting, and the establishment of role expectations (Blake-Beard, O'Neill, & McGowan, 2007; Wanberg, Kammeyer-Meuller, & Marchese, 2006). The mentoring skills required for these initial interactions and activities can be inherent, but are developed during strategically planned training programs. The peer mentor role requires careful planning, preparation, and training as well as continued guidance and supervision (Smith, 2008).

Learning Communities

Learning communities have been implemented in an attempt to foster student involvement and enhance the undergraduate experience. They are comprised of a self-selected group of students who share similar academic interests and explore them together in common courses and out of classroom experiences. In 1990, Gabelnick, MacGregor, Mathews, and Smith wrote *Learning Communities: Creating Connections Among Students, Faculty, and Disciplines* providing the most widely accepted definition of learning communities. According to Gabelnick et al. (1990), learning communities “purposefully restructure the curriculum to link together courses or coursework so that students find greater coherence in what they are learning as well as increased intellectual interaction with faculty and fellow students” (p.5). Learning communities are a practical multi-layered approach to the nation’s multifaceted problem with the ability to address a variety of academic needs while accommodating to the distinctiveness of the institution (Smith, 1991).

Students in these communities are clustered by a specific discipline or unifying theme and are required to take specific courses that are linked in content with other community members. This unifying experience enables them to form a community of learners while promoting social and academic integration (Kahrig, 2005). Learning communities emphasize the impact of peer groups, which have been underestimated and underutilized. Astin (1993) found peer groups to be “the single most potent source of influence on growth and development during the undergraduate years” (p.398). The literature indicates that learning community students nationwide experience more academic success, are significantly more involved on campus, and have retention rates that are ten to twenty percent higher than their non-learning community peers (Minor, 1997; Schroeder, Minor, & Tarkow, 1999; Johnson & Romanoff, 1999; Durrington & Bacon, 1999). They have also reported higher levels of satisfaction with their university experiences (Baker & Pomerantz, 2001).

The literature supports the positive effects of learning communities on academic outcomes and retention. In a study conducted at Eastern Washington University, learning community students earned a mean GPA of half a letter grade higher than their non-participating peers in an introductory Biology course (MacGregor, 1994). This program was an intensive integrated program of study, involving a first-year seminar and two content courses team taught by faculty (MacGregor, 1994). In 1993, Tokuno examined the GPA and retention rates of FIGS learning community participants and found that participants had higher GPAs and retention rates for all three years of the study, although only two out of the three years yielded a statistically significant difference in retention. Similarly, Baker and Pomerantz (2001) found that learning community participants at Northern Kennedy University had significantly higher fall GPAs compared to a control group. In another study conducted at LaGuardia Community College, a commuter school, students in learning clusters scored 12-14 points higher in a writing course than their peers (Hill, 1985, as sited in Friedman and Alexander, 2007). Learning communities do not favor or discriminate between disciplines of study.

Linked Courses Model: The linked courses model is the most basic form of a learning community. This model pairs two courses and requires that the learning community cohort is co-registered for the identified courses (Gabelnick et al., 1990). The courses are often described as "loosely linked" because instructors teach them individually, but coordinate syllabi and assignments (Lucas & Mott, 1996). For example, students may be required to take Elementary Algebra and Expository Writing, however all sections may not be taught by the same professor, but they contain learning community students and have similar, if not the same, syllabi and assignments. Learning community students participating in linked courses have the opportunity to interact with the same group of peers across their first-year classes (Tinto & Goodsell, 1994). This experience mirrors the social connections and integration of upperclassmen that are enrolled in smaller classes versus the large lecture halls reserved for introductory first-year courses (Bruffee, 1999).

Residential Learning Communities: Residential learning community programs are comprised of a cohort of students who are co-enrolled in two or more courses, which include a university experience course like traditional learning communities, but students are also housed together (Kahrig, 2005). Residential learning communities have developed in response to the need for increased social and academic integration on campuses nationwide. They combine the social residence hall environment with the academic learning community structure in an attempt to bridge the gap between the academic and social division that occurs in the first year (Tinto, 1996). The literature suggests that learning communities shape the first-year experience specifically by increasing student involvement, improving student performance, and impacting student retention (Levine, 1999). In a comparison between traditional residential students and residential learning community students, the latter had greater levels of involvement, faculty and peer interactions, integration, and intellectual development (Pike, 1999; Pascarella et al., 1994). More specifically, living-learning community participants have more frequent face-to-face interaction with faculty outside the classroom and are more involved in extracurricular activities than peers in traditional residential settings (Taylor, Moore, MacGregor, & Lindbald, 2004).

Tinto and Russo (1994) attribute the increase in student involvement to the program's ability to concurrently attend to students' social and academic needs. Learning communities provide students with increased "opportunities for deeper understanding and integration of the material they are learning, and more interaction with one another and their teachers as fellow participants in the learning enterprise" (Gabelnick et al., 1990, p.19). Leonard (1996) found that student involvement, as an outcome of learning community participation, was significant because it resulted in increased educational achievement and persistence. Social and academic integration leads to commitment and commitment leads to persistence and retention (Pike, Schroeder, & Berry, 1997).