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Psychological Sense Of Community And Retention: Rethinking The First-year Experience Of Students In Stem

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PSYCHOLOGICAL SENSE OF COMMUNITY AND RETENTION: RETHINKING THE FIRST-YEAR EXPERIENCE OF STUDENTS IN STEM

by

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ABSTRACT

This investigation looks at the relationship between a STEM learning community's co-curricular activities and students' perceived sense of community (SOC) to determine which activities most influence SOC and, in turn, retention. This investigation shows that SOC can be impacted by a multitude of factors found within the college environment. The most influential of these factors are open acceptance, student academic support services, and residential experiences. Most importantly there were significant differences for African American students participating in the STEM learning community on the measures of SOC, retention, and being on-track in mathematics. Additional data suggested higher levels of being on-track in mathematics for male students and differences in retention and being on-track for Hispanic students participating in a STEM learning community.

Dedicated to

my father, Ferris Dagley,

for providing his love, support, and devotion

and always believing in me.

I also dedicate this in memory of my mother.

The most beautiful and loving soul I have ever known.

Taken from us too early in life, I know you would be proud.

I miss you every day.

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CHAPTER I
INTRODUCTION

To keep America competitive in the future, we must trust in the skill of our scientists and engineers and empower them to pursue the breakthroughs of tomorrow.
-Former President George W. Bush, State of Union address 2008

It's time we once again put science at the top of our agenda and worked to restore America's place as the world leader in science and technology.
- President Barack Obama, 2009

Leaders in industry, government, and academia are concerned over the state of technological development and the future of America. For some time, officials have warned of the rapidly changing world, the shortage of American technology-based professionals, and the fact that the economic privileged position America once held is slowly vanishing (Friedman, 2005; Leath, 2005; The National Academies, 2007: Slater, 1999). In an effort to counteract this concern, leaders of industry, government, and academia have called for a doubling of the science, technology, engineering, and mathematics (STEM) graduates within the next 10 years.

Given the picture depicted by the reports of these scholars and in a day when institutions of higher education are being held more accountable by industry, government, and institutional leaders (Bailey, Bauman, & Lata, 1998; Berger & Lyon, 2005; Pappas Consulting Group, 2007; U.S. Department of Education, 2006), it is critical to devise strategies that are effective both in cost and outcomes to recruit, retain, and graduate more students in the STEM disciplines (Anderson-Rowland, 1997a, 1997b). For example, it has been proposed that faculty and student services should create appropriate campus culture and programming to promote student success (Cheng, 2004b; Kuh, Kinzie, Schuh, Whitt & Associates, 2005; Mortenson, 2005; Noel, Levitz, & Saluri, 1985; Pascarella & Terenzini, 2005; Rendon, Jalomo, & Nora, 2000). To do so, the effect of the students' experiences on their success, or lack there-of, must be identified. Speaking to one of the STEM disciplines, Dr. John J. Uhran, Jr., professor emeritus and former Senior Associate Dean of Engineering at the University of Notre Dame, made the following comment:

> Given that there is a serious lack of interest in engineering on the part of high school students and that the first year of studies impacts the way that students view their university experience, particularly if it is engineering, it appears appropriate to take a close look at what is going on in the first year of an engineer's education nation wide and to attempt a better understanding of what works or doesn't work. (personal communication, April 15, 2006, ¶ 2)

Further research must be conducted in order to provide faculty and staff with the information necessary to develop approaches to increasing a student's success, and ultimately his or her persistence to graduation, in the STEM majors.

For students to persist, they must become socially and academically integrated into the university (Tinto, 1975) and the associated communities found within. One area of retention research stemming from this concept has been the study of the relationship between student sense of community and intentionally planned learning communities. Most research in this area has been conducted on the effects of residence halls (Berger, 1997), or living-learning communities, student organizations (Lounsbury & DeNeui, 1996), classrooms (Ke, 2006), and undergraduate academic departments (Sanders, Basham, & Ansburg, 2006) as individual components in a learning community. This study investigated the sense of community concept using a more comprehensive approach to a learning community, one containing the necessary components for social and academic integration identified by Tinto (1975).

This study addressed the concept and historical foundations of retention and learning communities, how learning communities have been associated with retention of STEM students (Fromm, 2003; Light, 1990; Olds & Miller, 2004), and the development of sense of community within a learning community (Berger, 1997; Buck, 2006; Ke, 2006; Sanders, Basham & Ansburg, 2006; Wright 2004). This investigation sought to determine whether or not the learning community in question had established a sense of community among the participants, if there was any relationship to the retention of the participants in the STEM disciplines, and, if a relationship existed, were there differences in retention rates of comparable students (Fromm, 2003; Olds & Miller, 2004). Additionally, the investigation sought to identify whether underlying constructs of sense of community existed within the learning community and how powerful their influence was on student sense of community.

Purpose Statement

Literature supports the idea that a positive relationship exists between sense of community and student success (Bailey, Bauman, & Lata, 1998; Berger, 1997; Buck, 2006; Cheng, 2004b; Ke, 2006; Lounsbury & DeNeui, 1996; Rovai, 2002a; Sanders, Basham, & Ansburg, 2006; Wright, 2004). Based on these ideas, researchers at the University of Central Florida (UCF) designed a program with the goal of creating greater student success through the establishment of a learning community. Within this learning community students are nurtured through supportive programs and active participation by students, faculty, staff, and administration with the hope of creating a sense of community.

The overarching purpose of the research project was to determine the relationship between a holistic learning community, EXCEL (Note: EXCEL is not an acronym, but the actual name of the program), and the retention of STEM students through the first-year of college. For this investigation, retention was defined as students remaining in a STEM discipline through the first-year on to the second-year of college, more commonly known as fall-to-fall retention. Whereas, psychological sense of community was defined as “a feeling that members have a belonging, a feeling that members matter to one another and to the group, and a shared faith that members’ needs will be met through their commitment to be together” (McMillan & Chavis, 1986, p. 9). This investigation specifically explored if a relationship existed between perceived sense of community of EXCEL participants and factors such as the EXCEL out-of-class educational activities, placement in a learning community, and retention in the STEM disciplines.

Statement of Problem

The STEM pipeline, a commonly used analogy (Kuh, 2006; Tierney, 2000), has been shrinking. Evidence can be seen in the percentage of bachelor’s degrees awarded in the STEM disciplines as compared to the overall number of degrees awarded. The late 1960s holds the all time high for the percentage of bachelor’s degrees awarded in STEM disciplines at 36%. After a drop in the 1970s, this same statistic hit a high in 1985 and 1986 with 34% of all bachelor's degrees awarded in the U.S. Since that time the percentage dropped to a low of 30% in 1991 and rebounded slightly to 32% in 2006 (National Science Foundation [NSF], 2008). More disturbing is the fact that within this small percentage of degrees awarded in STEM disciplines, currently only 50% of those bachelor's degrees are awarded in the hard sciences, down from a high of 62% in 1986 (NSF, 2008). The hard sciences, the disciplines under investigation in this research, do not include psychology and the social sciences which make up the differences in the NSF STEM statistics. Shirley Ann Jackson, president of Rensselaer Polytechnic Institute, America's oldest technological college, called this a "quiet crisis" (Jackson in Friedman, 2005, p. 252). In his book, *The World is Flat*, Thomas Friedman reasserted Jackson's thoughts, "The shrinking of the pool of young people with the knowledge skills to innovate won't shrink our standard of living overnight. It will be felt only in fifteen to twenty years, when we discover we have a critical shortage of scientists and engineers capable of doing innovation…" (2005, p. 253). In response to the National Academies report, Andrew Card, former White House Chief of Staff, called for training of more students in the STEM disciplines (Leath, 2006).

The STEM pipeline continues to shrink. K-12 students are much less interested in science and engineering than in the past and are not as prepared to handle the college level work required to attain these degrees (ACT, 2006). A report by ACT, *Developing the STEM Education Pipeline* (2006), revealed that the percentage of the ACT-tested students interested in engineering had declined from eight to five percent over the last decade. Along with shrinking interest, one must take into account that previous longitudinal research by Adelman (1998) found that only 42% of those who enter college receive a bachelor's in their intended field of study. For STEM disciplines other than the life sciences, these percentages were lower (Adelman). With a lower percentage of students showing interest and a lower percentage of those declaring STEM disciplines completing a degree in their intended field, the outlook for increased percentages of STEM students entering the workforce is not promising.

With the shrinking number of students interested in engineering and other STEM disciplines, institutions of higher education must attract and retain more students in these disciplines in order to increase the number of graduates. It is in the best interest of the students currently in the pipeline, as well as easier and more cost efficient, for institutions to retain students than to recruit new ones (Anderson-Rowland, 1997a). Though the cost of recruitment is high, the cost of attrition can be greater. Habley (Habley & McClanahan, 2004) identified the costs of attrition on the university to include losses of tuition, fees, and faculty lines as well as increased recruitment costs. Other attrition related financial implications the institution must consider are lost revenues to the bookstore, cafeteria, housing, local businesses, and perhaps most important, the negative publicity that typically comes with losing students (Levitz, Noel, & Richter, 1999; Swail, n.d.). Student attrition affects more than just the university. Higher education provides benefits to both society and the individual. For example, 86% of those individuals age 18 to 64 who completed a minimum of a bachelor's degree were participating in the labor force in 2006 compared to only 76% of those individuals who completed only high school. The median annual income of males age 25 and over who completed a bachelor's degree, an associate's degree, or a high school diploma was $55,430, $42,460, and $33,070, respectively (U. S. Department of Education, 2007, p. 543-546).

One approach to increasing retention in the STEM disciplines is the EXCEL program, a STEP project funded by the National Science Foundation (NSF) and established at UCF in 2005. Taken from the proposal, "the goal of this project is to increase UCF's retention rates in STEM disciplines, thereby increasing the number of students graduating with a STEM degree. In this process an increase in the percentages of under-represented groups (women and minorities) graduating with STEM degrees is expected" (Georgiopoulos & Young, 2005, p. 1). Though similar NSF programs have been established around the nation, EXCEL is unique in the holistic nature of the approach. Research suggests that when faced with an ill-structured problem (Braxton & Hirschy, 2005; Braxton & Mundy, 2002) such as retention, multiple approaches may be better than a single solution (Kitchener, 1986; Wood, 1983)

The program, which targets students who are good in math but want additional assistance to be successful in the first two years of a STEM major, offers a holistic approach to programming. Holistic implies a multi-faceted approach to intervention with students, "encompassing academic affairs, student affairs, and administration" (Habley & McClanahan, 2004, p. 5). EXCEL provides intervention in each of these areas through math assistance, social programming, and involvement by faculty and advisors in a living-learning community. EXCEL promotes a small learning community of 200 students in a much larger university environment. Though still considered a large group by most standards, in context to the university size of over 50,000 students and the significant size of the individual colleges involved (see Table 1), 200 students makes for a smaller, more intimate, and navigable community. The EXCEL program investigators implemented a set of activities which can be divided into four categories: (a) advising activities, (b) faculty development activities, (c) educational activities, and (d) diversity activities (Georgiopoulos & Young, 2005).

Table 1.

2007 UCF EXCEL and STEM Enrollment by College

College/School	Total undergraduate	EXCEL STEM majors	EXCEL participants
Engineering & Computer Science	4,883	4,052	133
Sciences	8,277	2,041	33
Biomedical Sciences	1,677	1,655	8
Total	14,837	7,748	174

Source: University of Central Florida, Office of Institutional Research: Enrollment Profile.

The advising activities involve intrusive efforts from three fronts: the math faculty member, the designated EXCEL advisor, and the college advisor for the student's specific major. The faculty member advises on matters related to the student's performance in the math course. The EXCEL advisor deals with administrative matters, initial schedule planning, and monitoring the students overall progress while assisting with any situations that arise over the course of the first two semesters. The college advisor works to assure that the students are on track in their academic major and provides a smooth transition into the STEM discipline.

The faculty development activities involve training for the seasoned faculty members and the graduate teaching assistants who provide instruction in the required math and application courses. Each year prior to the fall term, best practices in math instruction are provided to the instructors. The trainer, a member of the Faculty Center for Teaching and Learning, monitors the courses to provide feedback on the implementation of the methodologies.

Established around the commonality and the critical nature of calculus as the curricular foundation of learning for each of the participating disciplines, the educational activities consist of those actions and events that were created to enhance classroom learning of the necessary calculus concepts. Applications of Calculus I and II were created to run parallel to the calculus courses. These courses discuss the application of concepts being studied in the corresponding calculus course. Students are enrolled as a cohort in this experience. The EXCEL Center was created as a place where the participating students can go for tutoring or problem solving sessions, meet with a study group, talk with an advisor, do homework, or on occasion, just socialize. The EXCEL residence hall community was established to allow students to live with others in the program to encourage informal study groups and an environment where students have the same academic purpose and common rigor in the coursework. The students have the opportunity to discuss homework with one another and seek assistance from their peers.

Additionally, tutoring and advising are offered to EXCEL students in the residence hall. Students are not required to participate in the EXCEL residence hall community and have the option to live in the EXCEL residence hall, another residence hall on campus, or in off-campus housing. One final component of the educational activities is the social integration of the students into the community. This includes, but is not limited to, the social activities provided for the EXCEL members and interaction with faculty, staff, and peers. All of the intentional activities of the EXCEL program are geared at assisting the students with their social and academic integration into the EXCEL and university communities.

Lastly, the diversity activities are established to educate students on different cultures and provide support for underrepresented students in the STEM disciplines. First, in the STEM disciplines, students will interact with a number of international faculty and graduate students. Understanding different cultures makes the EXCEL student a more educated individual and can assist the student in relating to faculty members in the discipline. Second, students in the program come from diverse backgrounds and may need additional supports within the program itself. Diversity activities make the students aware of resources available across the campus.

Due to time constraints related to the completion of this investigation and the extensive research conducted by others on the in-class and faculty development components, the investigation conducted in this study expanded only on the out-of-class educational activities. These out-of-class activities make up a significant portion of the learning community within EXCEL. The learning community activities included as part of this research project were participation in the residence halls, the social integration into the EXCEL community, and the activities of the EXCEL tutoring center.

There are a number of studies supporting the benefits of learning communities and the positive associated outcomes (DeNeui, 2003; Hotchkiss, Moore, & Pitts, 2006; Pike, 1999; Waldron & Yungbluth, 2007; Zhao & Kuh, 2004). Though more professionals in higher education are realizing the benefits of these learning communities, how do they know they are creating a community when they establish a new program? It is important to assess the activities of learning communities, but moreover, outside of academic characteristics, how is this accomplished? One method of measuring successful development of community is psychological sense of community within the group. Psychological sense of community has been shown to be stronger in small learning communities within the larger university community (Berger, 1997; Buck, 2006; Lounsbury & DeNeui, 1996). The concepts of community and participation in learning communities have been linked with higher levels of student persistence and success (Bailey, Bauman, & Lata, 1998; Berger, 1997). This research looked to investigate the relationship between a STEM learning community's out-of-class, or co-curricular, activities and students' perceived psychological sense of community to determine which activities most influenced sense of community and, in turn, retention.

Research Questions

Specifically, the study answered the following research questions:

1. What relationship, if any, exists between the educational activities of the EXCEL program and the psychological sense of community perceived among the EXCEL participants?

2. What underlying dimensions, if any, exist within the EXCEL experience and what are the relationships to a student's perceived sense of community?

3. What relationship, if any, exists between the first-year retention of EXCEL participants and their perceived sense of community?

4. What differences, if any, exist in the educational profiles of first-year EXCEL participants and non-participants?

Definition of Terms

The following definitions were offered to clarify terms used in the proposed study:

At-risk: Students who have been identified as possessing one or more characteristics that could be harmful to his or her continued academic progress at a specific institution. Students may be at-risk due to socioeconomic background, previous academic performance, standardized test scores, race, first-generation, non-traditional status, gender, etc.

Background characteristics: Also labeled pre-college characteristics, these are the pre-existing factors students bring with them to college. Often included in this category are high school grade point average (GPA) and achievement; performance on standardized tests; family background including income, socioeconomic status and parent's highest level of education; demographic characteristics such as gender, ethnicity, and religion; prior academic and social experiences; talents; skills; and aspirations (Astin, 1970; Pascarella & Terenzini, 2005; Tinto, 1975)

EXCEL: EXCEL is a STEP project implemented at UCF which is funded by the National Science Foundation (NSF). "The mission of the EXCEL program is to increase student success in the first two years of their college career in a STEM (Science, Technology, Engineering and Math) discipline" (EXCEL, n.d., ¶ 1).

First-Time in College (FTIC) students: “Referring to those students who have completed fewer than 12 semester hours and currently are in their first term as a UCF college student after high school” (University of Central Florida, 2007, p. 452).

Holistic approach: Multi-faceted approach to intervention with students “encompassing academic affairs, student affairs, and administration” (Habley & McClanahan, 2004, p. 5). For our purposes, Academic Affairs provides advising, tutoring, and faculty support while Student Affairs provides social and housing opportunities. Administration contributes by supplying adequate space and support for resources.

Learning community: “small subgroupings of students…characterized by a common sense of purpose… used to build a sense of group identity, cohesiveness, and uniqueness; to encourage continuity and the integration of diverse curricular and co-curricular experiences; and to counteract the isolation that many students feel” (Astin, 1985, p. 161)

Major change: “The process of changing a student's matriculation in one program to a different program” (*College Catalog*, 2005, ¶ 10).

Math on-track: Being on-track in the sequence of mathematics courses required for a student’s specific discipline of study. This determination is based on the mathematics course for which the student is enrolled in fall 2008 compared to the level of mathematics at which the student started, determined by the students enrollment in fall 2007.

Out-of-class activities: Also referred to as co-curricular activities, these are the activities created to enhance learning that occur outside the formal classroom. For our purposes, participation in the residence hall, tutoring center, and other social integration activities are included. Activities range from tutoring, problem solving, and study groups to socials and educational workshops.

Persistence: “the desire and action of a student to stay within the system of higher education from beginning year through degree completion” (Berger & Lyon, 2005, p. 7).

Psychological sense of community: “a feeling that members have a belonging, a feeling that members matter to one another and to the group, and a shared faith that members’ needs will be met through their commitment to be together” (McMillan & Chavis, 1986, p. 9)

Retention: “Measure of the proportion of students who remain enrolled at the *same* institution from year to year” (Hagedorn, 2005, p. 98). “Another type of retention takes a more limited view of the topic by viewing retention within a major area of study, discipline, or specific department” (p. 99). For our purposes, retention is defined as students remaining in a STEM discipline through the first-year on to the second-year of college, more commonly known as fall-to-fall retention.

SAT mathematics: The math portion of the Scholastic Aptitude Test (SAT) which “is an assessment used for University admission purposes (University of Central Florida, 2007, p. 453).

STEM: A commonly used term to identify programs dealing with disciplines in science, technology, engineering, and math (National Science Foundation, n.d., ¶ 2).

STEP: “The Science, Technology, Engineering, and Mathematics Talent Expansion Program (STEP) seeks to increase the number of students (U.S. citizens or permanent residents) receiving associate or baccalaureate degrees in established or emerging fields within” STEM (National Science Foundation, n.d., ¶ 2).

Significance of the Study

The need to increase the retention of STEM students in colleges and universities is well documented (Adelman, 1998; Business Roundtable et al., 2005; Friedman, 2005; Leath, 2005a; National Academies, 2007; National Science Board, 2008b; Slater, 1999). There are many paths to retaining students in a university setting. It is imperative that researchers continue to look for the best practices, or combination of best practices, that lead to greater student persistence. Learning communities and a student’s psychological sense of community have played important roles in increasing retention and student learning. Further study of sense of community and the connection to retention in smaller university communities is needed (Lounsbury & DeNeui, 1996) especially as they relate to STEM students. This study was unique in that it investigated the relationship of multiple variables to student sense of community and success in a STEM learning community.

The research conducted expanded the knowledge base on UCF students, provided vital data on students in programs identified as critical by the state of Florida, and contributed to the national data on sense of community and retention of STEM students. The knowledge gained from this study was expected to aid student service professionals in their efforts for retention of STEM students. If able to improve retention, results would be an increased rate of persistence and higher graduation rates. Successful completion of this research, showing a positive link to retention consistent with the literature, may further enhance the argument for continued support of similar programs by the National Science Foundation (NSF) and perhaps lead to additional funding opportunities through NSF for STEP Type II Educational Research projects.

Conceptual Framework

Borrowing a concept from the field of community psychology, the existence of sense of community, formally known as psychological sense of community (PSC), is one measure of a successful learning community (Sarason, 1974). The presence of psychological sense of community in the university setting is important in its potential effect on students and, for this investigation, its relationship to their retention within a program or institution. Though communities have been studied since the early 1920s, Sarason (1974) was credited for introducing the concept of PSC and suggested it be considered the centerpiece of the study of communities. However, it was McMillan and Chavis' (1986) work *Sense of Community: A Definition and Theory* on which most recent research in PSC has been based. McMillan and Chavis preferred the term sense of community (SOC) and defined it as, "a feeling that members have a belonging, a feeling that members matter to one another and to the group, and a shared faith that members' needs will be met through their commitment to be together" (p. 9). The definition consisted of four elements: membership, influence, integration and fulfillment of needs, and shared emotional connection. These elements interact within and among each other to generate and maintain SOC. Understanding the concept of SOC can aid institutional leaders in identifying factors and designing interventions that support behaviors (McMillan & Chavis, 1986) leading to SOC and potentially increase student retention. As sense of community was central to this investigation, a thorough examination of the individual elements comprising SOC and other definitions of community as they relate to a university setting were provided in the review of literature.

McMillan and Chavis' (1986) elements of SOC receive support from the popular retention theory of Tinto (1993), Braxton, Hirschy, and McClendon (2004), and Astin (1985) suggesting SOC as a good construct to use in the further examination of student retention. These supporting theories also provide encouragement for the use of learning communities to accomplish community within the institution. An explanation of the supporting retention theory and connections to SOC is necessary for a better understanding.

Vincent Tinto's (1975) interactionalist model of college student departure, though not the first study on the subject, created a national interest around the topic of student retention (Berger & Lyon, 2005). Tinto (1975) believed that a student's commitment to the institution and commitment to graduation led to departure decisions. This commitment impacted the social and academic integration of the student into the institution's community. Tinto suggested formal and informal areas such as academic performance, peer groups, faculty-student interaction, and extracurricular activities as places in which social and academic integration, also known as student involvement or engagement, would take place in an institution. In his revised work, Tinto (1993) later suggested that community membership and the membership's associated sense of belonging may play as critical a role in persistence as academic and social integration. In an attempt to provide more structure to the social integration construct of Tinto's theory and build on the idea of community, Braxton, Hirschy, and McClendon (2004) proposed a residential colleges and universities revision to Tinto's work which included the idea of "communal potential" (p. 23) as an influence on social integration. They described communal potential "as the extent to which a student believes that a subgroup of students exists within the college community with which that student shares similar values, beliefs, and goals" (p. 23). Developed around Tinto's integration activities and the idea of communal potential, first-year learning communities have been used to create welcoming subgroups in which students are immediately members, membership being the first step in an effort to build a sense of community (McMillan & Chavis, 1986) and, in turn, increase student persistence.

Based on his previous work and the idea of integration, Astin (1985), as part of his "theory of involvement," believed that "*Students learn by becoming involved*" (p. 133). Like Tinto he supported the idea of smaller community membership for purposes of assisting students to overcome loneliness or feelings of isolation on larger university campuses. Sarason (1974) believed loneliness and isolation could be combated by a strong SOC. The ideas of involvement and security, as proposed by Astin, are important elements of membership and establishing SOC in a community (McMillan & Chavis, 1986). In *Student Success in College*, Kuh, Kinzie, Schuh, Whitt, and Associates (2005) further supported the ideas of involvement and integration through the development of learning communities, stating, "living and learning with other students and faculty creates a community based on shared intellectual experiences and leavened by social interactions outside of class" (2005, p.198). These shared experiences and multiple opportunities for interaction suggested by Kuh et al. are important elements of SOC (McMillan & Chavis, 1986). Lenning and Ebbers (1999) defined learning communities as "an intentionally developed community that will promote and maximize learning" (p. 8). Since the 1980s, when the concept of learning communities found national prominence in higher education, many schools have implemented learning communities in an effort to increase student learning, sense of community, and persistence (Lenning & Ebbers, 1999).

In the literature review, the areas of college student retention, learning communities, and sense of community in the university setting were investigated further. A thorough review and critique of Tinto's model, details of Braxton, Hirschy, and McClendon's revision, and McMillan and Chavis' elements of SOC were provided.

Context

The University of Central Florida (UCF) is a large, selective, metropolitan university located in Orlando, Florida. Chartered in 1963 as Florida Technological University (FTU), classes were first offered in 1968. Under the guidance of the institution's second president, the university mission was expanded and FTU became the University of Central Florida. UCF, one of the eleven State University System institutions in Florida, is a Carnegie Foundation classified Research University (RU/H) offering degrees at the bachelor's, master's, and doctoral levels. The fifth largest university in the nation with a fall 2008 enrollment of 50,629 (UCF Office of Institutional Research, 2008), UCF's College of Engineering and Computer Science boasts the fourteenth largest engineering undergraduate enrollment in the nation (American Society for Engineering Education [ASEE], 2008).

The College of Engineering and Computer Science (CECS), the College of Sciences (COS), and the Burnett School of Biomedical Sciences (BSBS) each contribute to the pool of students included in the STEM disciplines identified by EXCEL. Fall 2007 undergraduate enrollments in the colleges and school were 4,883 for CECS, 8,277 for COS, and 1,677 for BSBS with the enrollments of majors included in EXCEL totaling

4,052, 2,041, and 1,655 respectively (see Table 1). Within the Bachelor of Science degrees included in EXCEL for fall 2007 entering students were 17 majors – Actuarial Sciences, Aerospace Engineering, Biology, Biotechnology, Chemistry, Civil Engineering, Computer Engineering, Computer Science, Electrical Engineering, Environmental Engineering, Forensic Science, Industrial Engineering, Mechanical Engineering, Mathematics, Molecular and Microbiology, Physics, and Statistics.

The EXCEL learning community consists of a myriad of activities: (a) advising activities, (b) faculty development activities, (c) educational activities, and (d) diversity activities (Georgiopoulos & Young, 2005). Some of these activities are required while others are optional based on student preference. Not all activities were included in this study, but to paint a clear picture of the holistic nature of the program, all of the activities were explained.

One of the required components of the program is the class cohort environment centered around the students' first and second semester math experience. During the fall semester of their first year in college, all EXCEL participants are enrolled in the appropriate math course with a cohort of other EXCEL students. Based on a math placement score or other test credit, students are enrolled in the Pre-calculus or Calculus I track. The Pre-calculus course is a five credit hour intensive review of Algebra and Trigonometry. This course serves as the prerequisite to Calculus I. Students enrolled in Calculus I, a four credit hour course, are also enrolled in an Applications of Calculus I course. The one credit hour applications course, taught by EXCEL faculty in different disciplines, illustrates real-world applications of calculus. Each of these courses are restricted to EXCEL students. Upon successful completion of the math course, students are enrolled in the next course in the sequence for the subsequent term. Students unsuccessful in their first attempt will be enrolled in an EXCEL section of the same course in the spring term. Each of these courses, Pre-calculus, Calculus I, and Applications of Calculus, are taught by EXCEL faculty and EXCEL graduate assistants. These instructors are trained through the Faculty Center for Teaching and Learning on best practices in the field.

Advising during the first year is handled through a team approach. The primary advisor for all EXCEL students is appointed by the First Year Advising and Exploration office and works with the students throughout their first year. The EXCEL advisor assists the students in all aspects of schedule planning and transition to the university. The faculty member and graduate assistant teaching the required EXCEL mathematics course work closely with the students in relation to issues in the classroom. Students performing below average are advised on appropriate actions to take: additional time in the EXCEL Center, one-on-one meetings with the class graduate assistant, or problem solving sessions with the instructor. As student performance changes so do the instructors' suggestions. The final member of the team is an advisor from the student's college or school. An academic advisor from each discipline (college advisor) works with the EXCEL advisor before and during the first semester to ensure the students are registered for the appropriate classes. At key points during the first year, EXCEL advising days are held in the EXCEL Center. Students meet with both the EXCEL advisor and the college advisor in order to make adjustments to course schedules and preparations for future terms. The advising days are key to showing a united front between the EXCEL program and the involved colleges and school and provide an opportunity for students to make a necessary connection with their future college advisor.

The out-of-class educational activities, those activities focused on in this research, have optional and required components. EXCEL students are offered the opportunity to live on campus in an EXCEL housing block. Students who choose to take advantage of this live together with other EXCEL students and are offered tutoring on-site in the residence hall. The living arrangements allow students to form study groups with students in close proximity, perhaps roommates, and engage in academic activities in an informal environment. Friendships are created with students in similar academic programs, lessening pressures between the academic and social systems of the university. The students provide a supportive environment for one another in which studying for classes is a positive activity. Social and educational activities are planned for all EXCEL participants. Each semester at least one to two large events are sponsored by the EXCEL faculty and staff. To date, programs have included rock wall climbing, a park picnic and outdoor activities, and semester kick-off dinners. A social committee made up of EXCEL staff and students plans smaller events throughout the semester typically centering around activities occurring on campus or small group outings for dinner, movies, bowling, or other local activities.

Students living both on- and off-campus participate in the EXCEL Center. As another testament to the holistic nature of the program and the support provided by the senior administration, the Center, which is reserved for the use of EXCEL students only, is centrally located in the academic heart of campus and directly across from the student union. The purpose of the Center is to provide a space where students can: (a) come together for group study, (b) receive individual tutoring by an EXCEL graduate teaching assistant, (c) participate in problem solving sessions with EXCEL faculty, or (d) meet socially after study hours. Participation in the activities of the Center begins as a required activity and becomes optional throughout the semester as students show improved academic performance in the required math courses. Initially, all first-year EXCEL students are required a base number of study hours in the Center. After the first quiz in the Pre-calculus and Calculus I courses, study hours are adjusted based on the student's performance. Required hours are lifted for students performing well and additional hours may be required for students performing poorly. Students are evaluated after each quiz or test and adjustments in the required hours are made. Additional benefits of the Center are the interactions between the first and second-year EXCEL participants, the interactions with graduate students in similar disciplines, and the interactions with the math and science faculty outside of the classroom.

Organization of the Study

Chapter 1 of this study consisted of a brief introduction of the study, the research questions, the context, and the conceptual framework used in the study. Chapter 2 was a review of the literature and relevant research on retention, STEM students, and psychological sense of community. Chapter 3 provided detailed information on the methodology and procedures used to collect and analyze the data. Chapter 4 described the steps of the statistical analysis and the results of that analysis. Chapter 5 summarized the findings of the study, made suggestions as to which components of the learning community showed the strongest relationship to a student's sense of community, and provided recommendations for practitioners and areas for future research.

CHAPTER II
REVIEW OF LITERATURE

The review of related literature was divided into three main sections. The first section on retention provided an historical overview of college student retention, covered the relevant theory to this research, discussed the areas of retention research focusing on the first-year experience, and concluded with a foundation for the study of learning communities. The second section focused on STEM retention research providing an historical overview, its importance, and ended with an emphasis on the use of learning communities and sense of community in the STEM disciplines. Lastly, the researcher investigated the concept of psychological sense of community, the use of the concept in higher education, and its significance to student retention.

Retention

A topic of research for over 75 years (Berger & Lyon, 2005; Braxton, 2000c; Braxton & Hirschy, 2005), retention has been referred to under many designations: dropout (Heilbrun, 1965; Rose & Elton, 1966; Spady, 1970, 1971; Tinto, 1975), departure (Braxton, 2000c; Braxton & Hirschy, 2005; Braxton & Mundy, 2002), persistence (Berger & Milem, 1999; Berger, 2002; Rossmann & Kirk, 1970), and attrition (Eaton & Bean, 1995; Tinto, 1982; Tinto, 1993). One of the earliest studies, conducted by McNeely (1937), even referred to the phenomenon as "student mortality" (Berger & Lyon, 2005, p. 5).

Early work in retention was based on studies focused primarily on four-year residential institutions looking at the majority population of the time – white males. Since then, research flourished with studies addressing different types of students, through cultural or socioeconomic diversity and gender in different types of institutions, including two-year and commuter colleges (Metz, 2004; Tinto, 2007). What researchers have found is that there "is no magic bullet" (Bean, 2005, p. 240). According to Pascarella and Terenzini (2005), "student growth along any one dimension is often highly related to, and perhaps even dependent on, growth along other dimensions" (p. 7). Research has shown that stopping out of college increases time to degree (Pascarella & Terenzini, 2005) and that attrition has been a constant in higher education and will continue to be (Tinto, 1982). Despite the fact higher education enrollments are at an all time high, graduation and retention rates have changed little in the last 20 years (ACT, 2008a; Ewell & Wellman, 2007; Marchese, 1994; National Center for Education Statistics [NCES], 2007; Tinto, 2007). Slightly over one out of every four students attending a four-year institution leave before the second year and statistics are worse in two-year institutions (Braxton, Brier, & Steele, 2008). There continue to be gaps in the success of diverse populations. High enrollment growth rates of African American students in the 1970s were hurt by high attrition rates (Lang, 2002). Low-income students are completing at a lower rate creating a problem for future generations where more than three-quarters of the college population are expected to be from low-income households (Ewell & Wellman, 2007). Short of "massive changes" (Tinto, 1982, p. 693) system-wide attrition will not change. However, institutions can work to improve their own retention rates.

Researchers have told higher education professionals what must be done to increase student success, specifically retention, within the institution. Pascarella and Terenzini (1991) believed that student persistence is the precursor to all other student outcomes. Frequent student interactions with faculty and peers were found to be among the most prominent influences on student persistence (Astin & Oseguera, 2005; Bean, 2005; Braxton, Brier, & Steele, 2008; Ewell & Wellman, 2007; Pascarella & Terenzini, 2005; Seidman, 2005; Tinto, 1975, 1993, 2000a). In addition to frequent interaction with students, researchers have encouraged faculty to implement active and collaborative student learning pedagogies allowing students to be more engaged in the learning experience (Ewell & Wellman, 2007; Pascarella & Ternzini, 2005; Tinto, 1997). Students need to receive constant and timely feedback with faculty and advisors implementing early warning and intervention systems (Ewell & Wellman, 2007; Study Group on the Conditions of Excellence in Higher Education, 1984; Tinto & Pusser, 2006). Support through both friendships and institution support services has been shown to be critical for student success, especially during the first year of college (Pascarella & Ternzini, 2005; Tinto, 2006). Researchers encouraged institutions to set high expectations for student learning with policies and practices that are clearly communicated (Braxton, Brier, & Steele, 2008; Study Group, 1984; Tinto, 2006). National professional organizations and researchers have called for a focus on student learning and outcomes, as learning leads to staying (ACPA, 1996; ACPA & NASPA, 1997; Kuh, Kinzie, Schuh, et al., 2005; Pascarella & Ternzini, 2005; Reason, Terenzini, & Domingo, 2006; Study Group, 1984;

Tinto, 1993, 2000a, 2006). However, the most repeated theme with an influence on student success is the integration or involvement of the student into the academic and social systems of the institution (Astin, 1999; Boyer, 1987; Kuh, Kinzie, Schuh, et al., 2005; Lenning & Ebbers, 1999; Pascarella & Terenzini, 2005; Schroeder & Mable, 1994a; Study Group, 1984; Tinto, 1975, 1993, 2006). Though involvement was beneficial to all students, higher levels of involvement or engagement in the institution were found to have greater effects on students "at-risk" due to being first generation in college, low-income, and even for African American and Hispanic students (Kuh, Kinzie, Buckley, Bridges, & Hayek, 2006). *Involvement in Learning: Realizing the Potential of American Higher Education* (Study Group, 1984) clearly called for institutions to implement what had been gleaned from the research of the day with the most important of those factors being student involvement. Institutions were called upon to facilitate student involvement by utilizing best practices which consisted of encouraging peer and faculty interaction, participation in student organizations, and devotion of energy toward academic study.

A similar call for turning theory to practice came again in 2006 at the National Postsecondary Education Cooperative (NPEC) Symposium on Student Success where institutions were encouraged to "act on what we know" and involvement was again discussed as a key factor for student success (Tinto & Pusser, 2006). With a similar message repeated 20 years apart, why are actions not being taken? Researchers know what works, but in fact, little has been done to translate theory and research into practice (Tinto, 2007). Tinto pointed out that the research tells practitioners what is important, but does not tell them how to achieve the effect, in this case involvement or integration. For those practitioners that do translate the research, the challenge becomes full implementation and sustainability (Tinto, 2007).

Who is responsible for this implementation? All aspects of a student's education were once the responsibility of the faculty (Barefoot & Gardner, 1993; Dwyer, 1989; Rudolph, 1990; Thelin, 2004). In today's higher education institutions faculty continue to play a prominent role, but have become responsible for fewer of the out-of-class activities as student affairs professionals stepped in. Researchers are quick to point out that retention and the institutional practices that influence student persistence are the responsibility of both student affairs and academic affairs practitioners (Berger & Lyon, 2005; Braxton, Brier, & Steele, 2008; Ewell & Wellman, 2007; Kuh, Kinzie, Schuh, et al., 2005; Rendon, Jalomo, & Nora, 2000; Schroeder & Mable, 1994a; Tinto, 1993). Braxton and Mundy (2002) suggested specific "domains of institutional practice that should bear responsibility" (p. 104). Included in this extensive list were academic programs, advisors, faculty, administration, admissions, institutional research, and the whole of student affairs. More and more research has shown that faculty interaction with students both in- and out-of-class is critical to retention (Astin & Oseguera, 2005; Bean, 2005; Kuh, Kinzie, Schuh, et al., 2005; Pascarella & Terenzini, 2005; Seidman, 2005; Tinto, 2000a, 2007). Support for a holistic approach to retention is evident.

These factors found to be important to the study of retention will be discussed in depth throughout the remainder of the literature review. At this time, clarification of the terminology used in the field is important.

Retention Defined

In *College Student Retention* (2005), Berger and Lyon provide a concise review of retention history and more importantly, a set of definitions summarizing the nomenclature associated with the topic. Those brief definitions were worth repeating for clarification of the different aspects of the study of retention.

1. Attrition: refers to the students who fail to reenroll at an institution in consecutive semesters.

2. Dismissal: refers to a student who is not permitted by the institution to continue enrollment

3. Dropout: refers to a student whose initial educational goal was to complete at least a bachelor's degree but who did not complete it.

4. Mortality: refers to the failure of students to remain in college until graduation.

5. Persistence: refers to the desire and action of a student to stay within the system of higher education from beginning year through degree completion.

6. Retention: refers to the ability of an institution to retain a student from admission to the university through graduation.

7. Stopout: refers to a student who temporarily withdraws from an institution or system.

8. Withdrawal: refers to the departure of a student from a college or university campus. (Berger & Lyon, 2005, p. 7)

Though much of the terminology has been used interchangeably in the research, there are distinct differences. Retention was the primary focus for this research. Just as there are differences in the terminology describing a student's attendance, or lack thereof, in college, there are also different types of retention. System retention describes the proportion of students who leave an institution, but eventually graduate within a proposed time period though not from the institution at which they began (Hagedorn, 2005; Tinto, 1993). This type of retention has been much more difficult to study as very few mechanisms are in place to track students' movements between institutions, especially if they transfer out-of-state. Tinto (1993) stated his concern regarding studies that used system retention data to recommend institutional policy and action.

The most commonly studied form is institutional retention (Hagedorn, 2005; Tinto, 1993). This is the retention measured by a student's attendance at one institution. Using a narrower definition than that proposed by Berger and Lyon (2005), institutional retention is a "measure of the proportion of students who remain enrolled at the *same* institution from year to year" (Hagedorn, 2005, p. 98). Using Hagedorn's definition as a foundation, the present study was concerned about retention through the first-year of college. Specifically, a more limited view of retention "within a major area of study" (p. 99), STEM disciplines, was used.

A Conversation Revisited

The conversation of retention and dropout is not unique to higher education. Throughout history, all levels of education have followed similar paths where attendance by many or all was preferred, suggested, and eventually required or essential. However, high schools reflect the best shared history of higher education. On the most basic level, like college attendance, high school was not required early on and typically only the elite made it to higher levels of education (Dorn, 1996). The expectation that everyone should graduate from high school or even attend was not always the case. Not until the twentieth century did graduation from either college or high school become a great public concern (Berger & Lyon, 2005; Dorn, 1996). Even the language was similar. Students were often referred to as dropouts and were segmented into voluntary (Tinto, 1975) and academically capable (Dorn, 1996) or involuntary and forced withdrawals.

Early conversations on keeping students in college and high school omitted critical topics like gender, race, and a person's right to an education (Attinasi, 1989; Dorn, 1996; Tierney, 1992). Programs were created to combat student attrition and increase persistence rates, but they were small with a limited scope and no system wide policy (Tinto, 1982). Therefore, only a small population was affected (Dorn, 1996). Funding was often limited and when it ran out programs ceased to exist. Programs in both high school and college became more symbolic than actually finding a real solution to the problem. More important, in both arenas researchers have had difficulty finding an appropriate single answer for measuring and improving retention (Dorn, 1996; Hagedorn, 2005; Pascarella & Terenzini, 2005).

The emphasis placed on stopping student dropout was a change in societal expectations and a reaction to the changing national climate not a drop in the number of students graduating. Graduation numbers continued to rise (Dorn, 1996; NCES, 2007) as the population attending high school and college grew. High school dropout and college retention rates have not changed substantially over the last 20 to 30 years despite massive amounts of programming (Dorn, 1996; ACT, 2008a). With the growing attendance size, schools have been criticized more often when students do not graduate (Dorn, 1996). Colleges and universities, like high schools, are being held more accountable by way of student retention to graduation (Pappas Consulting Group, 2007; U.S. Department of Education, 2006). With barely 71% of students at four-year, public institutions returning for the second year of college and only about 44% of this same group graduating in five years (ACT, 2008a), it is clear retention continues to be an issue of interest and one measure on which institutions of higher education wish to improve.

Historical Review

Student retention has not always been an important concept in higher education (Berger & Lyon, 2005). Prior to the start of the twentieth century, the study of retention was almost non-existent due to the fact degree earning was not important. Colleges in early America had small enrollments and were not concerned with the granting of degrees as the degree meant very little to society (Berger & Lyon, 2005; Thelin, 2004). Therefore, colonial colleges placed “little emphasis on completing degrees” (Thelin, 2004, p. 20) and more emphasis on educating boys to become men. The elite of society were trained to be lawyers and politicians while the lower class was trained to enter the ministry (Thelin, 2004).

In the late nineteenth century, retention of students to graduation was still not emphasized in the standard American college. A college building boom had occurred in the earlier part of the century and enrollments had increased due to America's expansion to the west and the admission of women (Thelin, 2004). Increased expansion in the areas of study occurred during this same period. It was determined that "all careers were equal, and all careers demanded an equal hearing and an equal opportunity within the university" (Rudolph, 1990, p. 341). National policy helped to stimulate the expansion of colleges when the Morrill Land Grant Act was passed in 1862 creating universities that would emphasize agriculture and engineering. However, due in part to the great expansion, institution survival not degree attainment, was the focus of American colleges (Berger & Lyon, 2005). Enrollments by this time had actually started to decrease even with the establishment of these new institutions, demonstrating that a college education was still not a desired commodity in America.

According to Berger and Lyon (2005), the start of the twentieth century, with America's great industrialization and urbanization, helped to stabilize colleges. Enrollments increased due to the need for training individuals for new types of jobs while others saw education as a "means to socioeconomic mobility" (Thelin, 2004, p. 155). The first roots of retention took hold when choice institutions started selective admission processes and actively recruited the country's elite. However, these selective institutions saw some "attrition as a hallmark of institutional success" (Berger & Lyon, 2005, p. 13) and were proud of their dropout rates.

Annual reports of enrollment during this time period were no more than year-to-year headcounts of students in each class: freshman, sophomore, junior, and senior (Thelin, 2004). No accounting was made for students who dropped out and were replaced by other students. Thelin gave one example from Kentucky State College. He suggested when the numbers were looked at more closely institution first-year retention rates went from 93% to 59% percent. The simple method of measurement often reflected high, but inaccurate retention rates. As the country became more industrialized, a college degree became more important to society and so too did the study of retention. One of the first studies of student departure, conducted by John McNeely, was published as early as 1937.

Post World War II saw increased enrollments that were fueled by national policy. The Servicemen's Readjustment Act of 1944 was instituted to assist returning soldiers in receiving the necessary education to re-enter the work force. International events such as the launch of Sputnik spawned the passing of the National Defense Education Act of 1958 and the Higher Education Act of 1965 (Berger & Lyon, 2005; Thelin, 2004). Both acts encouraged the higher education of America's young people in order to maintain the nation's prominent role in the growing global arena. In addition, the high school diploma was no longer seen as an efficient credential for future personal financial gain and societal success.

Open access to higher education for a more diverse student population created rising enrollments and issues with student retention throughout the 1960s. Institutions were seeing the largest African American and non-traditional student enrollments in the history of higher education. Retention rates were poor for those who were underprepared (Berger & Lyon, 2005). Enrollments continued to expand until the early 1970s when a decrease in college enrollments was predicted. According to Berger and Lyon (2005), this was the time when the study of retention became prominent. By the early 1990s, retention was an entrenched priority in higher education research. No longer concerned only with increasing enrollments, attention was turned to closing the widening gap between whites and ethnic minorities and between the socioeconomic classes.

Retention Theory

Theoretical Perspectives

Retention research incorporates elements of different theoretical perspectives. These perspectives, also called models and conceptual orientations, serve to determine the type of factors influencing student retention. Tinto (1993) described two theoretical perspectives, psychological and environmental, being at opposing ends of a spectrum. He classified the more commonly known theoretical perspectives of organizational, economic, and sociological within environmental. Due to the importance of these theoretical perspectives in the discussion on retention, the organizational, sociological, economic, and psychological theoretical perspectives are discussed in detail.

Organizational. Consistent with the name, the organizational perspective is represented by the role an organization plays in student departure. An organizations structure, characteristics, policies, and behaviors can affect retention of students at an institution (Braxton & Hirschy, 2005). Tinto (1986) proposed that faculty, administrator, and staff actions are included in organizational behaviors. Frames (Bolman & Deal, 2003) and models (Birnbaum, 1988) for organizations, specifically colleges and universities, that could be used to "foster or impede social integration and student departure decisions" (Braxton, 2000b, p. 261) have been proposed. Areas of study in the organizational perspective include Bean's (1980, 1983) model of work turnover to student attrition, institutional size and college "charter" (Kamens, 1971), institutional selectivity and expenditures (Gansemer-Topf & Schuh, 2006), college processes (Heverly, 1999), and presidential and administrative styles (Berger & Braxton, 1998).

Sociological. This perspective takes into account the forces within society influencing a student's decision to be retained or leave college (Braxton, 2000b; Tinto, 1993). A sociological view often neglects the institutional factors that play a role in student retention and departure (Tinto, 1993). Social forces influencing student persistence include peer and faculty interactions (Tinto, 1993), anticipatory socialization (Attinasi, 1989; Zurita, 2004), cultures (Kuh, 1995a; Kuh & Love, 2000), cultural and social capital (Bourdieu, 1986), and learning communities (Berger, 1997; Kuh, 2002; Tinto, 1997; Zhao & Kuh, 2004).

Economic. Economic forces at play on student persistence can best be expressed as the cost versus benefit analysis of attending college. Students must weigh the benefits of attending a specific institution against the costs associated with that attendance and the benefits of attending another institution (Braxton, 2000b; Braxton & Hirschy, 2005). If benefits are not perceived to be worth the cost, the student will leave the institution. Other economic forces influencing student persistence include the student's ability to pay (Cabrera, Nora, & Castaneda, 1992; Cabrera, Stampen, & Hansen, 1990), the impact of financial aid (Fenske, Porter, & DuBrock, 2000; St. John, Hu, Simmons, Carter, & Weber, 2004; Tierney, Sallee, & Venegas, 2007), and the interaction of other factors with finances (Cabrera, Nora, & Castaneda, 1993; St. John, Cabrera, Nora, & Asker, 2000).

Psychological. Perhaps the perspective focused on most in early studies of student persistence (Tinto, 1993), psychological models look at a student's attributes, attitudes, motivations, academic aptitude, personality traits, and abilities, among other traits, as they affect persistence or departure. The weakness of this perspective is that it focuses entirely upon the individual assuming that the departure decision is based on some "shortcoming and/or weakness in the individual" (p. 84). Studies based in the psychological perspective include Bean and Eaton's (2000) psychological model of college student retention, Astin's (1999) theory of involvement, and Milem and Berger's (1997) involvement with peers and social activities.

Early Theorists

While it was never before a concern, in the mid 1930s as colleges became more abundant, administrators and researchers turned to focus on students who were leaving college prior to degree attainment. Early studies such as McNeely's (1937) *College Student Mortality* focused on reporting information about those students who left the institution and making comparisons on those statistics. McNeely's study, conducted on more than 15,000 students, reported a 45% departure rate prior to graduation. The report also included reasons for student departure with the most important being failure, finances, and lack of interest.

Looking to move beyond mere tracking of reasons for departure and student demographics, Summerskill (1962) took the common psychological approach to investigating persistence by looking at the intellectual attributes of students as a primary predictor. Other researchers using psychological theory stressed student personality, maturity, motivation, and disposition in meeting academic demands (Heilbrun, 1965; Rose & Elton, 1966; Rossmann & Kirk, 1970; Waterman & Waterman, 1972).

Spady's (1970) original review of the literature on dropout identified six types of studies: (a) philosophical, (b) census, (c) autopsy, (d) descriptive, and (e) predictive. He felt these studies, which were conducted primarily in the 1950s and 1960s, were lacking in their ability to assist institutions in better understanding the problem. Spady was potentially the first person to use information on student characteristics and the environment to better understand student retention (Berger & Lyon, 2005). The interaction of the student with the environment provided the opportunity for the student to transition into the social and academic systems of the institution. If the rewards were high and relationships were established, social success was determined to exist and a student would persist. If rewards were insufficient, this would indicate the potential level for dropout (Harvey-Smith, n.d.). Spady found that a student's perception of social integration was a trigger for persistence (Tinto, 1975). According to Berger and Lyon

(2005), Spady's work was critical for three reasons: (a) it was the first effort to compile the work to date "into a cohesive conceptual framework" (p. 18); (b) it was grounded in sociology rather than the common psychological approach of the day; and (c) it served as the foundation for Tinto's future work.

Tinto's Interactionalist Theory

Most modern research (Berger & Braxton, 1998; Braxton, 2000c; Braxton, Sullivan, & Johnson, 1997; Burtner, 2004; Hagedorn, 2005; Milem & Berger, 1997; Nora, 2002; Pacarella, Terenzini, & Wolfle, 1986; Powell, Conway, & Ross, 1990; Reason, 2003; Sorenson, 2000) on retention takes root in Tinto's (1975) interactionalist theory of college student departure. Braxton (Braxton & Lee, 2005; Braxton, Hirschy, & McClendon, 2004; Braxton, Sullivan, & Johnson, 1997) called Tinto's theory near-paradigmatic based on the hundreds of works which have cited his theory and the considerable empirical study it has received. For this study, the empirical validity of Tinto's theory was not at question. Rather the underlying concepts of integration were used as a framework for understanding the relationships between factors involved in a student's first-year retention. For this reason, Tinto's theory was presented in detail.

Based in the sociological perspective, Tinto (1993) has stated the interactionalist theory of college student departure "is not a systems model of departure" (p. 112). Rather, the model investigates the longitudinal process of what transpires with students in regards to departure within a particular institution. Though taking into consideration the different backgrounds students bring with them and the external environments in which students must interact, the primary focus of the model is on events that occur after the student has entered the institution or, in instances like recruitment and orientation, those events occurring directly before entry into the institution (Tinto, 1993). Tinto described the goal of the model as seeking "to explain how interactions among different individuals within the academic and social systems of the institution and the communities which comprise them lead individuals of different characteristics to withdraw from that institution prior to degree completion" (p. 113) and encouraged its use to "institutional officials as a guide for institutional actions to retain more students" (p. 113). Tinto specifically wanted practitioners to be able to answer the question, how can the institution be changed to enhance retention?

Rooted in Durkheim's theory of suicide (1951) and subsequent interpretations of social integration by Spady (1970), Tinto (1975) believed that it was an "individual's integration into the academic and social systems of the college that most directly relates to his continuance in that college" (p. 96). In the revision to his earlier work, Tinto incorporated Van Gennep's (1960) *The Rites of Passage* and the stages of separation, transition, and incorporation. Tinto (1993) believed that for students to successfully integrate into, or become members in, the social system, which was critical for persistence, they must separate from past affiliations to be able to make the transition to college and eventually incorporate into the college systems. He conceded that these stages occur in varying degrees and sequences for different individuals and should not be interpreted literally for an educational community. However, it should be understood that students go through a process to become integrated into the academic and social systems of the institution and difficulties in any of these stages could lead to voluntary departure. In Tinto's own words, "though some degree of integration in the collegiate setting is seen as necessary for persistence, it need not imply the sort of conformity or consensus that Durkheim and Van Gennep may have envisioned in their work" (p. 105). Tinto suggested that over time the interactions between members of the institution's academic and social communities and those of a student with given background characteristics (e.g., family background, socioeconomic status, high school GPA, gender, pre-college preparation), intentions, and commitments directly contribute to the voluntary departure decision (Braxton & Lee, 2005; Tinto, 1993). When broken down, each student brings to college their own set of historical characteristics. Included in these characteristics are students' initial intentions and commitments. Each of the characteristics found within this history have some bearing on the degree of the student's integration into or involvement in the social and academic systems of the institution and a student's decision to stay or depart (Tinto, 1993).

Though external forces were considered in Tinto's (1975) original model, they were not prominently represented, but rather were reflected in the student's commitments to the institution and educational goal. In his revision, the college experience is viewed as "nested" (Tinto, 1993, p. 115) within the greater external environment that consists of family, friends, and communities with demands on the student unrelated to the institutional world. These external demands may alter a student's initial intentions and commitments independent of what occurs within the institution. These positive and negative integration experiences constantly modify a student's integration and intentions and commitments providing subsequent levels of intentions and commitments (Tinto).

To more thoroughly understand integration, Tinto (1993) expanded on the two systems within the institution. The academic system consists of anything related to "formal education" (p. 106) of the student including grades, occurrences in the classroom, intellectual growth, and interaction with faculty and educational staff. The social system consists of the daily interactions and social needs of individuals that take place outside formal academics including co-curricular activities and informal interactions with peers, faculty, and staff. These systems are interdependent in that what occurs in the academic system could easily influence interactions in the social system. Though integration or membership in these systems of the institution is important to a student's continued persistence, the integration does not have to be equal among them (Tinto). For example, a student may be integrated fully into the academic system, but not the social system or just the opposite. However, to remain at the institution a student must maintain some minimal level of academic integration. This is not so for social integration. Though a student may leave because social integration does not occur, it is not because they did not meet some requirement of social integration. Poor integration can also be tempered by a student's intentions and commitments. A student who is highly committed and intends to see their academic career through to a degree can overcome a lack of integration (Tinto).

Important to this investigation was the idea that student integration can occur not only at the institutional level, but also within sub communities within the organization (Kuh, 2002; Kuh & Love, 2000; Laufgraben, 2005; Tinto, 1993). Tinto suggested that integration or involvement may take place anywhere and that academic integration most influenced student learning. In *Leaving College: Rethinking the Causes and Cures of Student Attrition*, Tinto (1993) stated:

> there appears to be an important linkage between learning and persistence that arises from the interplay of involvement and the quality of student effort. Involvement with one's peers and with the faculty, both inside and outside the classroom, is itself positively related to the quality of student effort and in turn to both learning and persistence. (p. 71)

He later proposed to actively involve students in learning through the use of collaborative learning experiences in the classroom and learning communities (Tinto, 1998). Following the call of *The Student Learning Imperative* (ACPA, 1996) and *Principles of Good Practice in Student Affairs* (ACPA & NASPA, 1997) that all Student Affairs professionals should be supporting the institutional mission and educating students, future research would emphasize student outcomes based on learning (Kuh, Kinzie, Schuh, et al., 2005; Pascarella & Terenzini, 2005; Tinto, 1998). Though the connection between increased integration, or involvement, in the institution and the outcomes of learning and persistence were important, not everyone found Tinto's model to be the answer to the ill-structured problem of retention.

Opposition to Tinto

Though paradigmatic in terms of its ubiquitous acceptance, numerous researchers (Attinasi, 1989, 1992; Berger & Braxton, 1998; Braxton, 1999; Braxton & Hirschy, 2004, 2005; Braxton, Milem, & Sullivan, 2000; Braxton, Sullivan, & Johnson, 1997; Cabrera, Stampen, & Hansen, 1990; Christie & Dinham, 1991; Nora, 2002; Pavel, 1991, 1992; Rendon, 1994; Tierney, 1992; Tinto, 1982, 1997) have questioned the empirical validity, offered criticisms on the theoretical framework, and pointed to the shortcomings of Tinto's interactionlist theory, including Tinto himself. In an introspective look at the study of attrition, Tinto (1982) turned to his own theory as an example that the research had not yet explored the necessary areas to fully understand the topic. Tinto identified six shortcomings to the 1975 interactionalist theory of college student departure some of which he corrected for in his 1993 revision.

1. The theory explained some, but not all types of dropout. Specifically, he looked only at difference *within* institutions.

2. The theory considered, but did not focus on, entering student background characteristics.

3. The theory as proposed did not address financial or other external considerations.

4. The theory did not distinguish between institutional and system departure behaviors.

5. The theory did not account for the distinct differences in the educational career of a student based on race, gender, or social status.

6. The theory did not properly address considerations for two-year institutions (1982).

Taking Tinto's charge to improve existing theories and explore new areas, researchers have contested his model for the lack of consideration of diverse populations (Cabrera, Nora, Terenzini, Pascarella, & Hagedorn, 1999; Pavel, 1991; Rendon, 1994; Rendon, Jalomo, & Nora, 2000; Tierney, 1992), the use of Durkheim (1951) and Van Gennep (1960) as a theoretical base (Attinasi, 1989, 1992; Nora, 2002; Tierney, 1992), the exclusion of other theoretical perspectives (Baird, 2000; Bean & Eaton, 2000; Berger, 2000; St. John, Cabrera, Nora & Asker, 2000), and the lack of empirical evidence to support all of Tinto's theoretical propositions (Braxton, Sullivan, & Johnson, 1997; Braxton & Lien, 2000).

In *Reworking the Student Departure Puzzle*, (Braxton, 2000a) researchers came together to propose revisions to Tinto's theory and even new theoretical directions based on student behavior (Stage & Hossler, 2000), gender, race, and class (Rendon, Jalomo, & Nora, 2000), discourse analysis (Johnson, 2000), culture (Kuh & Love, 2000; Tierney, 2000), and institutional theorizing (Laden, Milem, & Crowson, 2000). Elaborations and other criticisms of Tinto's interactionalist theory of student departure are discussed further.

Influence of significant others. Tinto (1993) used Van Gennep's (1960) "rites of passage" to explain the process by which students' assimilate into the institution. Many researchers (Cabrera, Castaneda, Nora, & Hengstler, 1992; Cabrera & Nora, 1994; Cabrera, Nora, & Castaneda, 1992; Nora, Attinasi, & Matonak, 1990; Nora & Cabrera, 1993; Pascarella & Terenzini, 1991; Pavel, 1992; Rendon, 1994) have questioned whether Tinto's interpretation of the stages of separation, transition, and incorporation were "conceptually and culturally appropriate" (p. 42). Nora (2002) wanted to show how the "rites of passage" and the Student Adjustment Model (Nora, 1987; Nora & Cabrera, 1996) impacted a student's social and academic integration. Rather than the belief that students must "disassociate" (Tinto, 1997, p. 95) from past affiliations and communities, Nora believed that

> a supportive environment provided by family that encourages new perspectives and interests is key to the student's transition from high school to college, his or her integration into a new environment with new challenges, and ultimately the student's commitment to attaining a degree and his or her decision to persist or not. (Nora, 2002, p. 43)

Nora (2002) proposed that the impact of a supportive group of significant others, which included family, friends, and faculty, was "instrumental" (p. 52) to the academic and social integration of college students and their subsequent persistence or withdrawal.

Testing Tinto's propositions. John Braxton has been a leader in the testing of Tinto's interactionalist theory. Working collaboratively with many researchers he sought to challenge the empirical support for Tinto and elaborate on the original theory. Braxton, Sullivan, and Johnson (1997) identified and challenged 13 propositions from Tinto's original work. The usefulness of the propositions in explaining the relationships between the components of Tinto's model and their importance in the empirical testing of the model made them worthy of repeating.

1. Student entry characteristics affect the level of initial commitment to the institution.

2. Student entry characteristics affect the level of initial commitment to the goal of graduation from college.

3. Student entry characteristics directly affect the student's likelihood of persistence in college.

4. The initial commitment to the goal of graduation from college affects the level of academic integration.

5. The initial commitment to the goal of graduation from college affects the level of social integration.

6. Initial commitment to the institution affects the level of social integration.

7. Initial commitment to the institution affects the level of academic integration.

8. The greater the degree of academic integration, the greater the level of subsequent commitment to the goal of graduation from college.

9. The greater the degree of social integration, the greater the level of subsequent commitment to the institution.

10. The initial level of institutional commitment affects the subsequent level of institutional commitment.

11. The initial level of commitment to the goal of graduation from college affects the subsequent level of commitment to the goal of college graduation.

12. The greater the level of subsequent commitment to the goal of graduation from college, the greater the likelihood of student persistence in college.

13. The greater the level of subsequent commitment to the institution, the greater the likelihood of student persistence in college. (p. 9-10)

They assessed the propositions by the amount of empirical support that could be found for each. Empirical support was found for 5 of the 13 propositions. The most disturbing finding was that there was no strong single-institution support for the construct of academic integration when assessing persistence. Of the five propositions having empirical support, only four warranted further investigation as the fifth was not logically connected to the other four. The four propositions receiving empirical support were:

> Student entry characteristics affect the level of initial commitment to the institution. This initial level of commitment to the institution also influences the subsequent level of commitment to the institution. This subsequent level of initial commitment is also positively affected by the extent of a student's integration into the social communities of the college. The greater the level of subsequent commitment to the institution, the greater the likelihood of student persistence in college. (Berger & Braxton, 1998, p. 104)

Braxton and Lien (2000) continued the investigation into Tinto's propositions searching for empirical support for academic integration on subsequent institutional commitment and persistence. In doing so, Braxton and Lien found only moderate empirical support for academic integration in single-institution studies. One explanation offered was that Tinto's definition of academic integration was not precise. In addition to suggesting new ways to define or measure academic integration, Braxton and Lien also suggested the abandonment of academic integration in future research.

Influences on social integration. Even with these propositions supported, Braxton (Braxton, 1999; Berger & Braxton, 1998) believed the work was incomplete and called for further investigations into the influences on social integration which he believed were not thoroughly defined by Tinto. Using Tinto's interactionalist theory of college student departure as a framework, Christie and Dinham (1991) conducted a qualitative study testing the concept of social integration in the first year of college. Conducted at a large research university, the experiment included 25 randomly selected first-time full-time freshmen. A sequence of interviews was used to collect data. The primary influence found was the affect of external experiences on social integration, a previously neglected area by Tinto (1975). Elaborating on the changes in his later work (Tinto, 1987), the researchers found two influential external factors – high school friends and family. Not surprisingly, easy contact with high school friends *not* attending the same college hindered integration into the social system of the university while contact with high school friends attending the same college enhanced the process. Parents exerted both positive and negative influences on social integration and, in some cases, institutional departure. There were three key findings from the study. First, those external influences which took away from the time a student could devote to on-campus activities negatively influenced social integration and affected subsequent persistence at the institution. Second, if the external forces supported the student's educational goals and commitments, there was a positive influence on social integration. Tinto referred to these items as isolation and congruence. Third and most important to the research, was the expansion to Tinto's theory that external experiences must play a more prominent role, along with institutional experiences, when considering influence on integration into the social system of an institution (Christie & Dinham, 1991). Understanding the effect of external experiences for students and the potential differences for those living off-campus as opposed to on-campus was important to this investigation.

Basing their hypothesis on prior research in the field (Astin & Scherrei, 1980; Bean, 1980, 1983; Braxton & Brier, 1989; Kamens, 1971), Berger and Braxton (1998) proposed organizational characteristics be included when considering influences on social integration. Using theory elaboration, strong support was found for including the organizational characteristics of institutional communication, fairness in enforcement of institutional policy, and students' participation in decision making in the model (Berger & Braxton, 1998). Conducted at a private, highly selective research university, Berger and Braxton understood the limitation of generalizing their findings, but believed the work was important to filling gaps in the literature and that much could be gained by testing a theory at the "extreme ends of the behavioral spectrum" (p.106). Building on additional research of the period (Braxton & Hirschy, 2004 ; Cabrera, Stampen, & Hansen, 1990) and the proven influence on social integration of organizational characteristics, Braxton, Hirschy, and McClendon (2004) proposed a revision to Tinto's theory of departure for residential colleges using the four previously supported propositions identified to show partial support in residential institutions (Braxton, Sullivan, and Johnson, 1997) and six factors empirically proven to influence social integration: (a) ability to pay, (b) commitment of the institution to student welfare, (c) institutional integrity, (d) communal potential, (e) proactive social adjustment, and (f) psychosocial engagement (p. 22-27). Of relevance to this investigation were the factors of communal potential and commitment of the institution to student welfare as an influence on social integration. The student's belief "that a subgroup of students exists within the college community with which that student shares similar values, beliefs, and goals" (p. 23) and that the institution and faculty care for the student as an individual enhances the likelihood of student success in a learning community similar to the one considered in this investigation.

The classroom was used to attempt to further define influences on social integration. Cooperative learning (Tinto, 1997), active learning (Braxton, Milem, & Sullivan, 2000), and faculty teaching skills (Braxton, Bray, & Berger, 2000) all received support as influencing social integration and, indirectly, the intent to reenroll. Support for active learning was found with three of the four approaches having a statistically significant influence: (a) class discussions, (b) knowledge level examination questions, and (c) higher order thinking activities (Braxton, Milem, & Sullivan, 2000, p. 572). Faculty teaching skills of *organization and preparation* and *instructional skill and clarity* both received significance in supporting social integration.

Other areas of theoretical investigation to assist in the understanding of social integration and student departure include motivation type (Stage, 1989); financial aid (Cabrera, Nora, & Castaneda, 1992); fulfillment of college expectations (Helland, Stallings, & Braxton, 2002); institutional practices (Braxton & McClendon, 2002); institutional type (Pascarella & Chapman, 1983), self-efficacy (Peterson, 1993), student involvement (Milem & Berger, 1997), and residence halls (Berger, 1997; Christie & Dinham, 1991; Pascarella & Chapman, 1983). Berger's (1997) study on sense of community in residence halls and his collaboration with Milem (Milem & Berger, 1997) on the study of student involvement are discussed in more detail later in this review of the literature.

To summarize, Tinto's interactionalist theory of college student departure, though paradigmatic, can be improved upon by the addition of constructs from other theoretical perspectives (Braxton, 1999). With these elaborations to, or in some cases revisions of, the theory, a better understanding of student departure can be attained. In order to work towards solving the "departure puzzle" (Braxton, Sullivan, & Johnson, 1997, p. 107), it is evident that no one solution is going to work. A multi-theoretical approach is necessary (Braxton, 2002) with many policy levers (Pascarella & Terenzini, 1991).

Theoretical Support for Integration and Involvement

Despite opposition, Tinto's interactionalist theory of college student departure remains a strong framework to use in the study of retention where relationships based on social and academic integration are concerned. Using theoretical frameworks from Tinto and others, researchers have worked to identify retention programs and strategies based on a student's integration into the academic and social systems of the institution. No matter the term – integration, involvement, or engagement – student integration into the institution is what matters most to student retention (Tinto, 2007). Other retention theories that lend support to this idea and expand on Tinto's framework are discussed further.

Input-environment-outputs model (I-E-O). Astin's (1970) I-E-O model was developed to explain college effects on rather than the how and why of student change (Pascarella & Terenzini, 2005). Student outcomes consisted of three separate components: inputs, environment, and outputs. Inputs were defined as those characteristics that a student brings to college. Astin (1970) described these as the “raw materials with which the institution has to deal” (p. 225). The environment consisted of all aspects of the organization, including those which could be influenced by faculty and administrators at the institution, which affected the student outputs. Outcomes or outputs were those student characteristics existing after college. These characteristics included skills, knowledge, ability, interests, beliefs, and achievements (Astin). The importance of Astin’s I-E-O model is the support of investigating environmental influences on student outcomes, specifically focusing on those components which can be influenced by faculty and administration (Pascarella & Terenzini, 2005).

Theory of involvement. The early work of Spady, Tinto, and others led to the “age of involvement” (Study Group, 1984). Similar to Tinto’s idea of social and academic integration, Astin (1999) proposed a theory of involvement. He believed the more a student was involved, the more likely they were to be retained. He defined involvement as “the amount of physical and psychological energy that the student devotes to the academic experience” (Astin, 1999, p. 518). Though only implied by Tinto, Astin believed that the student’s quality and quantity of effort were central to their success.

The theory of involvement was based on five basic tenets. First, as stated in the definition, involvement requires the investment of physical and psychological energy on whatever object the student may be focusing. Second, there are different degrees of involvement by students on different objects and different students apply different degrees of involvement to the same object. Astin saw involvement occurring on a "continuum" (1999, p. 519). Third, involvement can be measured both quantitatively and qualitatively. For example, two students participate in a tutoring lab for five hours a week (quantitative). However, one chooses to form a study group while the other wastes time surfing the internet (qualitative). Fourth, the student outcome of learning from any program is proportional to the effort a student puts forth. Basically, students will get out of the experience what they put into it. Lastly, Astin stated that "the effectiveness of any educational policy or practice is directly related to the capacity of that policy or practice to increase student involvement" (p. 519). According to researchers (Astin, 1999; Pace, 1979; Pascarella & Terenzini, 1980b, 2005), the institution plays an important role by offering opportunities to students. However, growth or change occurs based on the students' quality of involvement in the opportunities made available (Pascarella & Terenzini, 2005). Following Astin's lead on tying policy to student success, Tinto and Pusser (2006) proposed a model of institutional action. In this model they suggested five conditions for student success, one of which was involvement. They referred to involvement as being interchangeable with social and academic integration. Focusing on what the student does, or the behavioral mechanisms rather than the perceptual, allows administrators to observe and more easily measure students' social and academic integration through their involvement (Astin, 1999). The theory of involvement is important to enhancing Tinto's concepts of social and academic integration.

In an attempt to empirically test the connection between Tinto's (1975) interactionalist theory of college student departure and Astin's (1999) theory of involvement, Milem and Berger (1997) proposed an integrated model of student persistence. Using the behavioral constructs from Astin to further define Tinto's concept of integration, Milem and Berger (1997) proposed that students' degree of involvement and perceptions led to subsequent levels of involvement and, in turn, persistence. They found a strong relationship between the initial involvement and students' perceptions of their experiences in college. As well, there was a strong prediction factor between early involvement and subsequent involvement. Milem and Berger cited that the research also provided additional support for the influence of the concepts of early faculty and peer interaction on persistence. In 1999, Berger and Milem revised the model to: (a) better account for indirect effects, (b) use a less liberal approach, and (c) use an actual measure of persistence rather than the students' intent to reenroll. Findings were similar to the earlier study and reinforced the idea of using Astin's theory of involvement to further Tinto's description.

General Model for Assessing Change. Pascarella (1985) proposed a model for assessing change in learning and cognitive development based on Tinto's core constructs. The model was intended to be general and aid in a better understanding of the influence of variables which would lead to more complete models. For purposes of this study, the importance lay within the emphasis on "interactions with agents of socialization" (p. 50), a continuance of Pace's (1979) quality of student effort, and the direct influence of these variables on student learning.

The model first suggested that students' background characteristics and the institution's structural and organizational characteristics have a direct influence on the "agents of socialization", namely faculty and peers, and the institutional environment. The interaction with faculty and peers directly affects the quality of student effort. In addition, students' background or pre-college characteristics have a direct influence on quality of student effort and learning. The institutional environment directly influences student quality of effort and interactions with faculty and peers which both directly influence learning and cognitive development (Pascarella, 1985; Pascarella & Terenzini, 2005). The importance of student and faculty interaction influences on learning and other student outcomes is well supported by the research (Astin, 1968; Bean & Kuh, 1984; Centra & Rock, 1971; Hyde & Gess-Newsome, 1999; Longwell-Grice & Longwell-Grice, 2008; Pascarella & Terenzini, 1978, 1980b; Terenzini & Pascarella, 1980). Pascarella and Terenzini (2005) believed the model could be used to explain change in other student outcomes in addition to student learning and cognitive development.

Important to this research, the concepts of student involvement and integration, the influence of environmental factors, and the importance of faculty and student interactions have been shown to have theoretical support for influencing student outcomes including retention. Discussion of these and other factors and their affect on retention continue, but were limited to the role played in the first-year in college.

The First-Year

The importance of the first year in college is evidenced by the sheer dedication of resources to the topic. In addition to the Policy Center on the First Year of College and the National Center for the First-Year Experience and Students in Transition, the National Orientation Directors Association, Noel-Levitz, Inc., the National Science Foundation, the Indiana University Center for Postsecondary Research, and UCLA's Higher Education Research Institute are only a few of the organizations committing abundant resources to investigating students during the first year, especially what works in retention. In a study conducted by Betsy Barefoot (n.d.a), co-director and senior scholar for the Policy Center on the First Year of College, she argued "that 'what's good for undergraduates' with respect to the quality of their educational experience – including, but not limited to retention – is essential for first-year students" (p. 6).

The first year in college has been identified as a critical time for students (Boyer, 1987; Tinto & Goodsell, 1993; Upcraft, Gardner, & Associates, 1989). During this period, students are most vulnerable (Cuseo, 2007; Mortenson, 2005). Many believe that drop-out decisions are made within the first few weeks on campus (Levitz & Noel, 1989, 2000; Noel, 1985; Ryan & Glenn, 2003; Tinto, 2001). The statistics support these facts. Despite the mass amounts of research on retention and the attempts at institutional intervention, first to second-year retention has not changed (Tinto, 1993) except in more selective institutions. In fact in 2007, based on a measure by ACT (2008a), retention of first-to-second-year students at four-year public institutions dropped to its lowest point in almost 20 years. Withdrawal is most frequent in the first year (Braxton, Brier, & Steele, 2008; Pascarella & Terenzini, 1980a; Tinto, 1982, 1993) with more than half of the students who ultimately withdraw from an institution doing so during this time (Cuseo, n.d., 2007; Terenzini & Reason, 2005; Tinto, 1987, 2001).

In a time when institutions are experiencing their highest enrollments in history the question arises has to why it is so important to retain a first-year student when they can easily be replaced. Retention is necessary because the costs of attrition for the individual, institution, and society are so great. Government, industry, and institutional leaders are holding institutions accountable for their actions (Bailey, Bauman, & Lata, 1998; Berger & Lyon, 2005; Pappas Consulting Group, 2007; U.S. Department of Education, 2006). Today more than ever, accountability, funding, and institutional rankings are being tied to retention and graduation of students (Berger & Lyon, 2005). In addition to federal and local funding, Schuh (2005) pointed out that there are direct, indirect, and long term costs for institutions. The direct costs consist of money spent on items like recruitment and merit aid, expenses that cannot be recouped, and also lost future income from lost tuition, housing, textbook sales, and any other secondary income. Indirect costs include the time of institution faculty and staff which could have been spent on efforts other than students who would not return to the institution. The long term costs consist of the loss of future benefactors, their time and money donated to institutional causes, the possibility for a poor recommendation of the institution to potential candidates (Schuh, 2005), or the negative publicity from low graduation rates

(Braxton, Hirschy, & McClendon, 2004). With these costs considered, an institution can have substantial savings when attrition is reduced even a small amount in the first year (Noel-Levitz, 2000). More important than the costs of attrition, institutions have a moral obligation to educate the citizenry. Individuals completing a bachelor's degree have higher lifetime earnings (Hagedorn, 2005; Schuh, 2005), greater employment stability (Cabrera, Burkum, & La Nasa, 2005), and an increased quality of life (Attinasi, 1992; Hossler, Braxton, & Coopersmith, 1989; Pascarella & Terenzini, 2005). Society benefits from an educated population as well. As technology advances the workforce must be educated to meet the need (Hagedorn, 2005; Tierney, 2000). The fields of science, technology, engineering, and math (STEM) are educating today's students for careers that may not yet be in existence (National Academy of Engineering, 2003). A stronger economy, a decrease in long term poverty, and engagement in civic and political activities are only a few of the benefits to society (Cabrera, Burkum, & La Nasa, 2005; Hagedorn, 2005; Pascarella & Terenzini, 2005). Braxton, Hirschy, and McClendon (2004) stated it most eloquently, "Retention is an issue of importance for individuals (future opportunities), for institutions (financial success, accountability, and moral commitment to a supportive environment), and for the nation that strives to develop a workforce and citizenry to support the future" (p. xi).

Institutions employee a number of strategies to battle attrition in the first year, including programmatic interventions. Tinto (1993) suggested seven principles for effective implementation of retention programs. Among those was the call for institutions to “frontload their efforts” (p. 152). Supported by others (Cuseo, 1991; Kuh, 2002; Kuh, Kinzie, Schuh, et al., 2005; Levine, 1994; Mortenson, 2005), retention efforts are believed to be the most powerful during the first-year of college – the earlier, the better. But why is the first year so important? For the last 20 years, institutions have consistently lost 27-30% of their students before the beginning of the second-year (ACT, 2008a). Levitz, Noel, and Richter (1999) found that attrition rates drop each year the student is retained after the first year. Review of UCF College of Engineering and Computer Science retention data supports this claim (see Table 2). Levitz et al. stated that the “first-to-second-year attrition rate is perhaps the most important determiner of an institution’s graduation rate” (p. 36). They believed the transition to college could be made easier by institutions that step up to meet the needs of these students. According to Levitz et al., intrusive and proactive strategies are needed to catch students before they fail, “It has been our experience that fostering student success in the freshman year is the most significant intervention an institution can make in the name of student persistence” (Levitz & Noel, 1989, p. 65).

Institutional resources committed to the first-year assist students in starting off strong both academically and socially (Kuh, Kinzie, Schuh, et al., 2005). Early intervention programs supported by these resources should encourage integration into the university community (Beil, Reisen, Zea, & Caplan, 1999). This academic and social integration, or involvement, matters most in the first-year (Tinto, 1998, 2007) because it influences future integration into the institution (Terenzini & Wright, 1987). It matters most because first-year academic performance has been linked to persistence (Noel-Levitz, 2008a; Terenzini & Reason, 2005), but more importantly, and most relevant to this investigation, almost 70% of the growth in math and science skills have been shown to occur in the first two years (Pascarella & Terenzini, 2005). The first year is key to "laying the foundation on which their [students] subsequent academic success and persistence rest" (Reason, Terenzini, & Domingo, 2006, p. 150). During this critical first-year, institutions have the ability to quickly react to issues (Mortenson, 2005; Tinto & Goodsell, 1993). However, to react appropriately institutions must know their first-year students. Important characteristics of the 2005, 2006, and 2007 entering college cohorts are discussed further.

Table 2.

UCF CECS Year-to-Year Attrition Rates by Percentage (2000-2007)

Cohort	Attrition rates by year				
	1	2	3	4	5
2000-2001	34.1	19	5.2	.8	1.6
2001-2002	31.7	17.7	4.8	3.4	1.2
2002-2003	33.9	16.9	5.2	1.7	1
2003-2004	30.4	19.8	7	2.9	
2004-2005	32.6	17.4	5.9		
2005-2006	32.7	16.4			
2006-2007	29.1				

Source: University of Central Florida, College of Engineering and Computer Science: Retention Data.

First-Year Student Characteristics

Based on data collected using the Cooperative Institutional Research Program (CIRP) Freshman Survey, researchers at the Higher Education Research Institute [HERI]

(2007) found that the 2006 entering freshman class consisted of the most diverse population in higher education in race, gender, and age since 1971. The number of Asian American/Asian, Latina/o, and American Indian students continued to grow while the percentage of African American students held steady after a rapid increase in the 1980s and a slight decrease in the late 1990s. Women made up 55% of the population. Older first-time students had more than doubled since data was first collected in 1967 and there was "a decline in the proportion of first-generation freshmen" (p. 1). An additional trait that could play a role in a student's institutional commitment and, in turn, persistence at that institution, was the increase in the percentage of students applying to multiple institutions (HERI, 2007, 2008). The percentage of students applying to six or more institutions has almost doubled in the last decade (HERI, 2008) and according to the National Association for College Admissions Counseling the trend will continue (Clindinst, 2008). Of concern to this investigation were the findings that: (a) in the subject areas of science and computer science the level of students completing the "recommended years of study" (HERI, 2007, p. 2) in high school remained low; (b) the perceived need by students of college remedial work in math and science increased slightly; and (c) high school "academic habits" (p.2) were taking a turn for the worse with more frequent tardiness and less time spent on studying. Additionally, though diversity in the pipeline is positive, the STEM disciplines have traditionally struggled in attracting and retaining women and underrepresented populations (Building Engineering & Science

Talent [BEST], 2003; Kahveci, Southerland, & Gilmer, 2006; National Science Board, 2008b; National Science & Technology Council, 2000).

Though conducted earlier than the previous study, the 2005 Your First College Year (YFCY) Survey allowed for over 38,000 first-time, full-time students to provide their opinions, not just expectations, of the first year in college as a follow up to the CIRP Freshman Survey. The HERI (n.d.) claimed it was the largest sample of first-year student data collected. Though overall satisfaction with the first-year of college was the predominant theme, students' actual experiences fell short on some accounts. The HERI reported that over half of the students came late to class and some felt bored in class or even skipped class. Relevant to this investigation, though students related they were successful in peer interactions, they were less successful in getting to know their professors or understanding academic expectations. A portion of the students even felt "intimidated by their professors" (¶6) possibly reducing the out-of-class meeting encounters.

The College Student Inventory (CSI), administered at the beginning of the undergraduate experience, questions students about the characteristics brought with them to college and expectations of the first year. In the study conducted by Noel-Levitz (2008b), entering first-year students for fall 2007 expressed their commitment to the goal of education with a staggering 95% arriving "highly motivated to complete a degree" (p. 1). Despite the good news about students' perceived commitment, knowing that over 50% of students entering a public institution fail to receive a degree (ACT, 2008a; Kiser

& Price, 2008; Tinto, 2001), the question must be posed, what happens to students between entry and departure? Another disheartening fact for this investigation was that almost half of the students entering four-year public institutions reported a weakness in math and science (Noel-Levitz, 2008b). However, in the same study almost 60% of students reported having a good strategy for note taking and studying for courses. A large percentage of students at four-year public institutions were open to math assistance, tutoring, and help in improving study habits and test taking strategies. This is important as it comes at the time when students are most open to assistance – during the first year (Barefoot & Seigel, n.d.). So, what can be done?

First-Year Strategies

The literature is rich with research on different approaches for retaining students in the first year of college. These approaches, or retention strategies, are often applied either for prediction or control (Astin & Oseguera, 2005). Prediction, as it implies, attempts to determine the likelihood of some student outcome while control seeks to increase our ability to achieve a particular outcome, in this case retention and ultimately graduation. Institutional retention strategies begin with the recruitment process and continue through the end of the first year. Some of the more common techniques are discussed here.

Pre-college characteristics. One common strategy is the use of pre-college or background characteristics. These characteristics are used to predict which students are more likely to persist or to identify students who are at-risk and should be targeted with intentional programming. Many of the more widely held theories take into account some form of background characteristics. Tinto (1975) initially looked at family background, individual attributes, and pre-college schooling. In his 1993 work, Tinto grouped these into a category labeled *pre-entry attributes*. Astin's (1970) I-E-O Model considered demographic characteristics, family background, and pre-college academic and social experiences as inputs. Pascarella's (1985) general model for assessing change, Weidman's (1989) model of undergraduate socialization, Nora's (2004) student engagement model, and Braxton, Hirschy, and McClendon's (2004) revision of Tinto's theory for student departure in residential colleges and universities are other examples where consideration was given to student entry characteristics. These characteristics have been found to have both a direct and indirect influence on student persistence (Pascarella and Terenzini, 2005; Tinto, 1993).

An attempt to create a model for early identification of students at-risk of departure used an integration of Tinto's (1975) interactionalist model, Bean's (1982) student attrition model, and Astin's (1975) theory of involvement. Glynn, Sauer, and Miller (2003) took into consideration a number of student background variables and student values in an attempt to predict student attrition as early as possible in the college career. Using the CIRP Freshman Survey, administered during orientation, and additional in-house survey research, the researchers were able to create a model with a predictive ability of 83% with high school GPA being the strongest predictor of attrition. This model was found to be valuable for retention staff developing early interventions to prevent attrition.

Using CIRP data from the fall of 1994, Astin and Oseguera (2005) looked at the predictive nature of pre-college characteristics and influences of environmental contingencies and institutional characteristics on student degree attainment at four and six years. The researchers found that, consistent with the literature and previously discussed research, high school GPA continued to be the best pre-college predictor of degree attainment. Other contributing student characteristics included intact, affluent, and well educated families and willingness of the student to get involved both socially and academically. Astin (2006) confirmed that several entering student factors predicted degree completion. However, he took research on using pre-college characteristics to predict degree attainment a step further when he suggested that "*an institution's degree completion rate is primarily a reflection of its entering student characteristics*, and *differences among institutions in their degree completion rates are primarily attributable to differences among their student bodies at the time of entry*" (p.7). He challenged institutions and agencies holding these institutions accountable to look at the "expected" rates of degree completion for each institution as well as their actual degree completion rates to get a true accounting of how the institution performed when it came to retention and graduation of students. He believed this true picture of retention would aid institutions in facilitating degree completion. In the same study, Astin suggested a similar comparison between expected and actual student engagement rates commenting that most institutions should not be blamed or exalted for low or high engagement of students unless pre-college characteristics were first taken into account.

The comprehensive model of influences on student learning and persistence was developed by Terenzini and Reason (2005) as part of the Foundations of Excellence® in the First College Year Project. This initiative was "a two-year national research and development effort to increase understanding of the multiple, interconnected factors that influence academic success and persistence among first-year college students" (p. 3). Using this model and the 2003 and 2004 National Survey of Student Engagement (NSSE) data, Reason, Terenzini, and Domingo (2006), while controlling for pre-college characteristics, found that what happened to students during their first year of college explained more about their academic competence than the characteristics they brought with them. Specifically, the "students' perception of the support they received" (p. 164) was most influential. The researchers proposed that "academic competence in the first year of college appears to be influenced by multiple factors, including factors related to students' experiences, faculty and peer cultures and environments, and institutional policies" (p. 171).

It is obvious that student background characteristics influence retention, academic performance, and degree completion in college. In fact, motivation and academic preparation are the greatest predictors of degree attainment (Kuh, Kinzie, Schuh, et al., 2005; Pascarella and Terenzini, 2005). However, as Kuh, Kinzie, Schuh, et al. (2005) clearly stated, outside of highly selective institutions, universities cannot typically pick only the best applicants. For this reason, and the fact that retention is influenced by subsequent student involvement as well as institutional behavior, it is what happens after entry into the institution and during the first year that matters most (Pascarella & Terenzini, 2005; Tinto, 1987). This investigation assumed likewise and further detailed a few proven institutional strategies.

Institutional strategies. Knowing the characteristics, attitudes, and goals of the entering student body is important for professionals within the institution hoping to influence retention (Braxton, 2003). Having this knowledge allows professionals to evaluate which programs should be implemented to enhance student involvement, learning, and, in turn, institutional retention. Based on recommendations from the literature for early intervention (Kuh, 2002; Kuh, Kinzie, Schuh, et al., 2005; Levine, 1994; Mortenson, 2005; Tinto, 1993), these programs typically occur directly prior to entry – bridge programs and orientation – or during the first semester, sometimes carrying through the first year. A few of the more common first semester programs (Upcraft et al., 1989; Upcraft, Gardner, Barefoot, & Associates, 2005) include freshman seminars, first-year advising programs, support services and centers, and learning communities. For purposes of a better understanding of the topic, a brief background was provided on the common strategies not studied in this investigation.

Orientation is one of the handful of strategies that have become common retention practices at institutions across the country. The National Survey of First-Year Co-Curricular Practices (Barefoot & Siegel, n.d.) reported that almost 100% of the respondents, which included two- and four-year institutions of all Carnegie classifications, offered a form of orientation. A large number even reported *requiring* orientation. Participation in orientation programs has been found to increase social integration and persistence (Pascarella, Terenzini, & Wolfle, 1986) for first-year students. Mullendore and Banahan (2005) defined orientation "as a collaborative institutional effort to enhance student success by assisting students and their families in the transition to the new college environment" (p. 393). The timing and length of the programs investigated by Barefoot and Siegel (n.d.) varied by institution size and type and student needs. They reported that not only attendance at, but what a student *does* during the orientation is important. Braxton and McClendon (2002) suggested orientation activities aimed at students interacting socially with their peers would be advantageous to their social integration into the institution. Institutions also recognized the importance of including academic as well as social activities as part of orientation. This practice allowed for earlier faculty-student interaction at some institutions (Barefoot & Siegel, n.d.) and intellectual exchanges such as assigned readings and discussion groups at others ("New Student Orientation Trends", 2004). Orientation programs have expanded to include multi-day outdoor (Brown, 1998) and wilderness (Gass, 1990; Gas, Garvey, & Sugerman, 2003; Mullendore & Banahan, 2005) themes as well as opportunities for specific groups such as African Americans (McNeil, 1990), Hispanics, honors (Barefoot & Siegel, n.d.), adults, and online learners (Scagnoli, 2001) to have targeted orientation programs that better suit students' transition needs. In this way, orientation has a positive effect on the social and academic integration into the first year of college (Fox, Zakely, Morris, & Jundt, 1993) and, in turn, an effect on student persistence (Rode, 2000).

Bridge programs are another pre-entry strategy. This type of intervention is offered for four to seven weeks during the summer prior to the first year in college. Minorities due to race (Gold, 1992: York & Tross, 1994) or gender, underprepared students (Garcia, 1991), low-income students (Buck, 1985), or other populations such as STEM students (Gilmer, 2007) are often the target. Students participating in the summer programs may or may not be attending the host institution (Gilmer, 2007; Raab & Adam, 2005). Contact with the participants after the initial program varies by institution. Some institutions continue interventions throughout the first year (Raab & Adam, 2005) or perhaps on to graduation (Gilmer, 2007). Others have little contact past the event end date. Not all bridge programs report significant increased retention after the first year (Wolf-Wendel, Tuttle, & Keller-Wolff, 1999; York & Tross, 1994), but in these programs and others citing increased retention (Walpole, Simmerman, Mack, Mills, Scales, & Albano, 2008) significant improvement in academic and social integration in the first year occurred.

Freshman seminars are courses designed as an extension of the process which begins at orientation (Barefoot & Gardner, 1993). Formerly known as orientation courses, freshman seminars "aim to assist students in their academic and social development and in their transition to college" (Hunter & Linder, 2005). Over 100 years old, orientation courses lost favor as the number of students entering higher education rose drastically after World War II, but saw a revival when the population became more diverse in the 1970s and more personalized sessions were needed to deal with the different transition needs of each group within the population (Barefoot & Gardner, 1993). Due mostly to the efforts of the National Resource Center for The First-Year Experience (Strumpf & Sharer, 1993), 94% of the institutions in the nation offer first-year seminars (Barefoot, n.d.b). The types of seminar courses vary. According to Barefoot (n.d.b), seminars may (a) encompass an academic focus or theme; (b) be discipline specific covering both an introduction to the profession as well as the institution; or (c) focus on learning or academic skills. These courses are often credit bearing, one to three hours, and small in size, 25 or fewer students. Similar to other first-year efforts, sections of the seminar classes can be offered for specific subpopulations to better focus on transition and success issues individual to those groups (Hunter & Linder, 2005). Extending the already proven retention benefits of an orientation program in a thoughtful, well planned manner "would both reinforce and magnify its [course] influence" (Pascarella, Terenzini, & Wolfle, 1986, p. 172). Seminars enhance student success by increasing a student's sense of community, involvement in the institution, and social and academic integration (Barefoot, n.d.b). These concepts are forged from a strong theoretical framework consisting of Boyer's (1987) idea of community, Astin's (1999) theory of involvement, and Tinto's (1993) interactionalist theory.

Academic advising during the first year of college is critical (Habley, 1981; King & Kerr, 2005). When speaking about advisement Levine (1986) stated, "The freshman year is the best chance we have to touch the hearts and minds of our students. For many students, it is our only chance" (p.6). In a 1988 address to the National Academic Advising Association (NACADA), Tinto stated that advising was at the very core of effective retention programs, similar to Habley's (1994) suggestion that advising is the hub of the wheel not just another service provided to students (Nutt, 2003). David Crockett (1984) defined advising as:

> "a developmental process, which assists students in the clarification of their life and career goals and in the development of educational plans for the realization of these goals. It is a decision making process by which students realize their maximum educational potential through communication and information exchanges with an adviser; it is continuous, multifaceted, and the responsibility of both student and adviser. The adviser serves as a facilitator of communication, a coordinator of learning experiences through course and career planning and academic progress review, and an agent of referral to other campus agencies as necessary." (p. 1)

The question for first-year advising has never been if it should occur, but instead, how it should occur. Institutional leaders must determine the appropriate method of advising "based on the mission and organization of an institution and the needs of its students" (King & Kerr, 2005, p. 321). Habley (1983) outlined seven organizational models for advising: (a) faculty only, (b) satellite, (c) self-contained, (d) supplementary, (e) split, (f) dual, and (g) total intake. Each advising model had advantages and disadvantages for first-year students. The faculty only model, as the name implied, assigned students to faculty advisors upon entry. The positive effect of this and other faculty involved models is the early faculty-student interaction which has been shown to positively influence retention (Pascarella, Terenzini, & Wolfle, 1986). The satellite model assigned students to advisors within the colleges with an eventual transition to a faculty member in that college. Relationships could be formed with the academic unit upon entry to the institution (King & Kerr, 2005) rather than having a potentially difficult transition from a unit external to the student's academic home. Similar to this was the total intake model which assigned students to a centralized advising office with a hand-off to the faculty at a designated point in time. Though this approach front-loaded interventions for first-year students, possible disadvantages were lack of initial faculty involvement and a difficult transition to a new advisor. Showing a decrease in recent years (King & Kerr), the self-contained model provided advising for all students from first year through to graduation. A major weakness is that this model does not provide any faculty-student interaction. The supplementary, split, and dual advising models were all variations of a faculty-advising office combination wherein the faculty and advising office worked together to serve the student. These "shared models" (p. 326) have seen an increase over the past decade. Effective first-year advising can facilitate student involvement in their learning (Kramer & Spencer, 1989), which is key to persistence.

Each of these institutional strategies enhances commitment to the institution, student involvement in the social and academic systems of the institution, and, in turn, retention. One additional strategy, not new to institutions, has proven useful for increasing retention, academic achievement, learning, and personal development as well as promoting community and integration into the social and academic systems of the institution (Lenning & Ebbers, 1999). Tinto (2006) suggested that learning communities should be the “hallmark of the first year experience” (p. 4). Learning communities and the related interventions relevant to this study were discussed in greater detail.

Learning Communities

Throughout history, learning communities have been both broadly and narrowly defined depending upon the context of the user. For this investigation, a broad definition was used so as to encompass the entirety of the learning community rather than one individual component. Learning communities “represent an intentional restructuring of students’ time, credit, and learning experiences to build community, enhance learning, and foster connections among students, faculty, and disciplines” (Smith, MacGregor, Matthews, & Gabelnick, 2004, p. 20). Learning communities are made up of groups of faculty and students that are smaller than other groups on campus and are often grouped together through some type of co-enrollment (Laufgraben, 2005). A brief review of the history of learning communities, the types of learning communities, definitions, and a discussion of purpose and student outcomes was provided as they were significant to the understanding of the learning community concept. The review concluded with a thorough discussion of the co-curricular areas included in this investigation.

Historical Review

At the most basic level a learning community is “an intentionally developed community that will promote and maximize learning” (Lenning & Ebbers, 1999, p. 8). Whether in Greek or Colonial times, higher education was thought to be the act of bringing together a community of scholars (Lenning & Ebbers, 1999). These “learning communities" were a spontaneous creation of higher education where teachers and students came together to prepare the student for their role as citizen (Lenning & Ebbers, 1999; Shapiro & Levine, 1999). As education diversified, becoming more fragmented and unrelated, and institutions grew in size, the small, interpersonal settings where faculty-student interaction and integrated, intellectual sharing could take place were harder to find (Lenning & Ebbers, 1999). Gabelnick, MacGregor, Matthews, and Smith (1990) stated it best

> the collegiate learning community refers to an *idealized version of the campus of the past*, [italics added] where students and faculty shared a close and sustained fellowship, where day-to-day contacts reinforced previous classroom learning, where the curriculum was organized around common purposes, and the small scale of the institution promoted active learning, discussion, and individuality. (p. 9)

Learning communities that once developed on their own by bringing together a small community of scholars were vanishing. To recapture these learning communities institutions would have to be more intentional in their efforts.

The early influences on learning communities include John Dewey, Alexander Meiklejohn, and Joseph Tussman. According to Gabelnick et al. (1990), Dewey's influence "had less to do with structure and more to do with the teaching and learning process" (p. 15). Dewey believed that the learning experience must be student-centered, be influenced by the interaction between teacher and student, and promote active learning (Shapiro & Levine, 1999). He was critical of the compartmentalization of subject matter learning (Gabelnick et al., 1990). Perhaps his greatest contribution to learning communities is found in his influence on the active teaching pedagogies most adopted by learning community instructors (Smith et al., 2004).

Both Dewey and Meiklejohn were concerned about the fragmentation and specialization of the educational system (Gabelnick et al., 1990; Shapiro & Levine, 1999; Smith et al., 2004). Early efforts to recapture the connectedness of learning and prepare students for their role as citizen brought about one of the first "organized learning communities initiatives" (Shapiro & Levine, 1999). Meiklejohn created an undergraduate experimental college at the University of Wisconsin based on discussions of the "great books". From 1927 to 1932, the Experimental College consisted of an "integrated, full-time, two-year, lower division program focusing on democracy in fifth-century Athens and nineteenth- and twentieth-century America" (Gabelnick et al., 1990, p. 11). Using what they learned, students were requested to apply it to a study of their hometown. Meiklejohn's vision of the undergraduate curriculum consisted of structure, unlike the elective system of the day which allowed students to choose courses with potentially no connection (Shapiro & Levine, 1999). His Experimental College centered on building a community of learners around a common context in the curriculum. The first bulletin on the Experimental College (Meiklejohn, 1927) outlined the faculty-student relationships that would exist, the formation of community with the college, and the organization of the courses of study. Meiklejohn believed that the community would support the learning of the group (Smith et al., 2004). The residential component of the Experimental College was seen as an important part of the community building process as it could assist in bringing together the curricular and co-curricular. Similar to learning communities in practice today, tutoring and other forms of active learning were used. Meiklejohn’s project also faced problems similar to some modern learning communities. Competition for resources, challenging the norm of the institution, feelings of favoritism towards the students and faculty involved in the initiative, and the constant pull on the faculty by the academic department and the program were all included as factors that led to the end of the Experimental College (Smith et al., 2004) and are often the reasons modern learning communities are not sustained. Meiklejohn’s vision of a community built by faculty and students coming together to learn, focusing the undergraduate curriculum around an integrated set of courses for a better understanding of the context in which they lie, and using residential, active learning, and other co-curricular experiences to foster a sense of community can be found in modern learning communities.

Some 30 years later Joseph Tussman and Mervyn Cadwallader revived Meiklejohn’s idea of a lower division experimental college at Berkeley and San Jose State College, respectively. They too challenged the use of traditional courses and instead opted for integrated programs. These programs required faculty to work together to plan the curriculum because one faculty member or one discipline could not cover all the necessary concepts (Gabelnick et al., 2004; Shapiro & Levine, 1999). The content was similar to that of Meiklejohn’s. Additions to Tussman’s experience were a seminar run by the students and a place designated for the program participants to call their own. Cadwallader expanded the content at San Jose to include themes of science and the environment which were relevant to that time period (Smith et al., 2004). Like Meiklejohn's Experimental College, developing a sense of community was a significant outcome of the experiments. Cadwallader was very intentional in adding structure to the program in subsequent years and in building a sense of community. Though both short lived, lasting only from 1965 to 1969, these experiments served as the foundation for the future leaders of the learning communities movement (Smith et al., 2004).

After the experiment at San Jose State College and a brief failed attempt at establishing a similar program at the State University of New York (SUNY) – Old Westbury, Cadwallader participated in the creation of The Evergreen State College. Here the ideas of Meiklejohn and Tussman were adopted from the inception of the institution by the founding faculty. Centered around "year long, coordinated studies programs that would be full-time, team-taught, and organized around interdisciplinary themes" (Smith et al., 2004, p. 47) Evergreen became a leader in modern learning communities. Around the same time others were developing new programs and joining the learning community movement. Roberta Matthews was experiencing success at LaGuardia Community College with paired and clustered courses while Patrick Hill developed federated learning communities at SUNY – Stony Brook. Serving two distinct populations it was necessary to develop different strategies. Faith Gabelnick experienced success with honors programs and encouraged the use of the seminar as the center of learning (Smith et al., 2004). All of these efforts came together after the hiring of Patrick Hill as the Provost for Evergreen in 1983. Soon after, The Washington Center for Improving the Quality of

Undergraduate Education was formed to disseminate learning community information throughout the state. The Washington Center has become a resource on learning communities throughout the nation.

The learning community movement found support in the National Institute of Education's (1984) *Involvement in Learning* which called for transforming undergraduate education. To accomplish this goal, student-faculty involvement was seen as a critical component. The report specifically recommended: "Every institution of higher education should strive to create learning communities, organized around specific intellectual themes or tasks" (p. 35). The suggestion was also made to front-load these resources in the first and second year where they would be most beneficial. In the late 1990s other studies produced by the Kellogg Commission (1997), the American Association of Higher Education, the American College Personnel Association, and the National Association of Student Personnel Administrators (Joint Task Force on Student Learning, 1998), and the Boyer Commission on Educating Undergraduates in the Research University (1998) all made recommendations to improve the student learning process and each encouraged the use of learning communities to meet those goals. A national movement by the year 2000, learning communities have been adapted to meet the needs of the students and the nation while fitting the institutions within which they reside (Smith et al., 2004). However varied the implementation, learning communities can be grouped into three common categories: learning organizations, student learning communities, and faculty learning communities. For a more thorough understanding of modern learning communities, the categories, general purpose, benefits, and characteristics of effective learning communities were discussed in detail.

Types of Learning Communities

In *The Powerful Potential of Learning Communities*, Lenning and Ebbers (1999) identify two important "dimensions" of learning communities that must be taken into consideration: primary membership and primary form of interaction. Each dimension consists of three categories. For primary membership these categories are (a) learning organizations, (b) faculty learning communities, and (c) student learning communities (p. 10). The primary forms of interaction are (a) physical interaction, (b) virtual interaction, and (c) correspondent interaction (p. 11). Lenning and Ebbers made it clear that these groups and forms of interaction are not mutually exclusive. Overlap can occur when faculty participate in a student learning community or when a community participates in physical and virtual interaction. For purposes of this investigation, student learning communities with primarily physical interaction were the focus. All further references to learning communities assumed this categorization.

Within the category of student learning communities there are four types or structures. The majority of all learning communities can be grouped as follows: (a) curricular learning communities, (b) classroom learning communities, (c), student-type learning communities, and (d) residential learning communities (Lenning & Ebbers). Laufgraben (2005) identified a fifth type of structure as on-line learning communities. This review was limited to the types identified by Lenning and Ebbers (1999).

The type used most often throughout the historical development of learning communities, and thus the most commonly researched and replicated, is the curricular learning community. Defined, curricular learning communities “intentionally link or cluster two or more courses, often around an interdisciplinary theme or problem, and enroll a common cohort of students” (Smith et al., 2004, p. 67). Typically offered in the first or second year of study, the purpose is to provide intentional interaction among students and with faculty around specific disciplines or themes in order to build community and provide a deeper learning experience (Lenning & Ebbers, 1999; Smith et al., 2004). Curricular learning communities were originally represented by five models: (a) freshman interest groups, (b) linked courses, (c) course clusters, (d) federated learning, and (e) coordinated study (MacGregor, Smith, Matthews, & Gabelnick, 2002). Over time, the typology was condensed to three models which encompass the original five. The differentiation between the models comes in “the degree to which the teaching teams work together to foster connections among their courses” (Smith et al., 2004, p. 71). Learning communities in courses that are unmodified is the first approach. Previously identified as freshman interest groups (FIGs) this curricular approach requires minimal or no coordination between the faculty teaching the courses. A cohort of students enrolls in a set of courses centered on a specific discipline of study (Gabelnick et al., 1990). Many or all of these courses may be large sections that enroll more than the FIGs cohort. Additionally, the cohort registers in a small seminar course led by an undergraduate student where connections are made between the FIGs courses. Another variation on a discipline specific seminar is a Freshman Year Experience course. This smaller, peer led course aids in the transition into the academic and social systems of the institution, making connections within the discipline, and building community within the cohort (Smith et al., 2004). Simple and cost effective to implement (Gabelnick et al., 1990), this approach works well for large institutions or those in the initial stages of developing learning communities. Originally developed at the University of Oregon, successful FIGs are now offered across the nation. One drawback of the FIGs approach is the limited faculty involvement in the process. However, consistent interaction with a common peer group allows for peer social and academic networks to be formed. An additional advantage of a discipline specific cohort is the benefit of knowing students in future courses (Tinto & Goodsell, 1993).

Learning communities of linked or clustered courses is another approach. Here a set of courses are paired or clustered around a theme and only students in the cohort register for these courses. Though the academic content of each course remains intact, faculty collaborate by planning and creating syllabi with links between the courses (Shapiro & Levine, 1999). The assignments linking the topics create coherence in the curriculum (Smith et al., 2004). The pure cohort model allows for greater connectivity between the courses and deeper interaction between the students and faculty. There are many variations within the linked or clustered approach which can include a pure cohort placed in larger courses or clusters of four courses with two small and two large sections (Smith et al.). The larger the cluster the more complex scheduling issues become. Care should be taken to not make every course a student takes part of the cluster. Despite the benefits of the cohort, students like the opportunity to meet others outside of their primary group.

The final approach to a curricular learning community is team-taught programs. Formerly referred to as coordinated studies or federated learning communities, these programs also group together two to four courses around a common theme. However, unlike the linked courses, team-taught programs are highly integrated with faculty working together to plan the courses and adopt a common syllabus. Maximum faculty involvement is required for this effort. The themed, often interdisciplinary, programs take many forms, but most are centered on a seminar course which allows for discussion and creation of connectivity between members of the community. Faculty-to-student ratios are small with no more than 20 to 25 students participating in a seminar (Lenning & Ebbers, 1999; Smith et al., 2004). Regardless of the approach to the curricular learning community efforts must be intentional. Though cohorts present a spontaneous community of learners, if there is "no *intentional* effort" (Smith et al., 2004, p. 81) to encourage community and create connection between the courses, "the learning *and* the community are less powerful than they could be" (p. 81).

The second learning community structure is the classroom. In the study of retention, classroom learning communities have not been explored to their fullest potential. Tinto's (1997) research at Seattle Central Community College supported the idea that as student populations have become more diverse and more commuter institutions have appeared, the classroom has played a more significant role in the development of the academic and social involvement of students with peers and faculty and, in turn, learning and persistence. Lenning and Ebbers (1999) identified two strategies for classroom learning communities: total-classroom and within-classroom. The total-classroom has not been as common in higher education due to the traditional teaching pedagogies used by faculty and the limited time students spend in the individual classroom. The goal of a total-classroom learning community is to "develop a sense of family, or community, across the classroom, [so that] all the students in the class view themselves as members of a distinctive learning community" (p. 29). Time and effort are required to restructure the classroom setting to encourage this type of large scale learning community. More common are within-classroom learning communities which constitute four to five person groups that work together towards a common goal (Lenning & Ebbers). To be effective learning communities the groups must be what Johnson, Johnson, and Holubec (1998) describe as "cooperative learning groups". Characteristics of these groups include positive interdependence, individual accountability, heterogeneous membership, shared leadership, responsibility for each other, emphasis on task and maintenance, teaching social skills, observation and intervention by the teacher, and group processing (Lenning and Ebbers, 1999, p. 31). Classroom learning communities allow students to become active rather than passive learners and to develop peer support groups that continue outside the classroom (Tinto, 1997). Students become involved socially as well as academically in the institution which creates a greater opportunity for learning and persistence. The first two learning community types discussed, curricular and classroom, can be used for all students, but are critical in meeting the needs of commuters as there may be no other opportunity to reach this population (Tinto, 1998).

The third type of learning community is student-type. These learning communities bring students of a particular population together. Included in these groupings are learning communities for students or groups who may be academically underprepared, underrepresented, disabled, honors participants, commuters, or share common academic interests (Lenning & Ebbers, 1999; Laufgraben, 2005). For this investigation, the learning community consisted of students with common academic interests in the science, technology, engineering, and mathematics (STEM) disciplines. Documentation of the success of student-type learning communities centering on the STEM disciplines was presented in further detail later in the review of literature.

The final type of learning community, and the one most relevant to this investigation, is the residential learning community, often called living-learning centers. Students living in residence halls have been shown to have higher levels of (a) social interaction with faculty and peers, (b) persistence, (c) satisfaction with the institution, and (d) commitment to the institution to name only a few positive outcomes (Lenning & Ebbers, 1999). These benefits increase when intentional learning communities are introduced to the residence hall (Pascarella, Terenzini, & Blimling, 1994). There is no consensus to the definition of living-learning programs (Brower, 2007). Many programs house students based on common interests or around a particular theme (Smith, 1994), similar to their curricular counterparts, but without requiring a curricular component. Though a connection between the co-curricular and curricular may be forged through the introduction of themes, academic interests, and even support programs delivered on site, the involvement of faculty in the residence hall may remain almost non-existent (Smith et al., 2004). However, residential learning communities can be expanded and used in conjunction with curricular learning communities. These living-learning communities adapt one of the curricular strategies and enhance the learning effects with a residential component (Laufgraben, 2005; Shapiro & Levine, 1999). Students have the opportunity to carry their conversations outside the classroom and into their living environment which allows for an overlap between students' social and academic activities (Laufgraben, 2005; Tinto, 2006). Smith et al. (2004) defined living-learning communities as a place to "build community and integrate academic work with out-of-class experience" (p. 20).

As with the dimensions identified by Lenning and Ebbers (1999), the types of learning communities are not mutually exclusive. Learning communities can have a cross between types utilizing components of each to enhance student outcomes. The EXCEL program, which is under investigation here, creates a learning community based on cohort participation in two paired classes along with a residential component based on students' specific academic interests. Due to the combination of curricular, residential, and student-type approaches, a broad definition of learning communities was used. For this investigation, Astin's (1985) definition of learning communities fit best:

> small subgroupings of students…characterized by a common sense of purpose… used to build a sense of group identity, cohesiveness, and uniqueness; to encourage continuity and the integration of diverse curricular and co-curricular experiences; and to counteract the isolation that many students feel. (p. 161)

Furthermore, these learning communities "represent an intentional restructuring of students' time, credit, and learning experiences to build community, enhance learning, and foster connections among students, faculty, and disciplines" (Smith et al., 2004, p. 20). With a better understanding of the types of learning communities and, specifically, the broad perspective used in this investigation, an explanation of the purpose and characteristics of learning communities was necessary for comprehending the use of this first-year retention strategy.

Why a Learning Community?

The review of literature has shown that to increase the chances of retention, students must be involved early with both faculty and peers in the academic and social systems of the institution (Cuseo, 1991; Kuh, 2002; Kuh, Kinzie, Schuh, et al., 2005; Levine, 1994; Mortenson, 2005; Tinto, 1993). Learning communities assist in making this happen (Gabelnick et al., 1990). Institutions implement learning communities as a way to increase student involvement, build community, create a connection to the curriculum, enhance student-student and student-faculty interaction, and ultimately retain students (Laufgraben, 2005; MacGregor et al., 2002; Tinto & Goodsell, 1993). These connections are most potent if they occur within the first semester of college (Laufgraben, 2005; Shapiro & Levine, 1999). Levitz & Noel (1989) suggested that retention efforts must focus on adjusting to college. To do this, programs must be devised that connect students to the campus, aid in their transition to the institution, and help them to meet their academic goals and succeed in class. According to Smith et al. (2004), learning communities meet these needs.

> Learning communities aim to foster a sense of community and shared purpose among learners and their teachers. They attempt to create curricular coherence and connections among courses and ideas, and to teach skills in meaningful contexts. They aspire to develop students' capacity to make both academic and social connections as maturing college learners. Learning communities offer a more intensified learning environment by providing more time for students to develop these connections, both through the classroom learning afforded by taking multiple courses together and out-of-class activities such as study groups, project work, and co-curricular experiences. (p. 68)

Though some benefits occur spontaneously when students are placed into cohorts (Smith et al., 2004), learning communities must be intentionally developed if they are to meet all of these needs. To aid in the process of institutions being intentional in their efforts, Schroeder (1994) outlined six principles to be incorporated into the development of effective learning communities:

1. Learning communities are generally *small*, unique, and cohesive units characterized by a common sense of purpose and powerful peer influences.

2. Student interaction within learning communities should be characterized by the four I's – involvement, investment, influence, and identity.

3. Learning communities involve bounded territory that provides easy access to and control of group space that supports ongoing interaction and social stability.

4. Learning communities should be primarily student centered, not staff centered, if they are to promote student learning. Staff must assume that students are capable and responsible young adults who are primarily responsible for the quality and extent of their learning.

5. Effective learning communities should be the result of collaborative partnerships between faculty, students, and residence hall staff. Learning communities should not be created in a vacuum; they are designed to intentionally achieve specific educational outcomes.
6. Finally, learning communities should exhibit a clear set of values and normative expectations for active participation. The normative peer cultures of learning communities enhance student learning and development in specific ways. (p. 183)

Successful creation of these communities of learners strengthens the fight against the ill-structured problem of retention (Braxton, Hirschy, & McClendon, 2004). However, for institutional efforts to be successful, students must interact within the learning community. Schroeder (1994) believed this interaction and the four principles associated with it were "integral to the establishment of any peer learning community" (p. 175). He believed these principles would remain constant between different types of learning communities even though the goals and purpose of each may differ. Schroeder described the learning community interaction effect as being associated with the four principles of involvement, investment, influence, and identity on the part of the student. Involvement by students is an expected component of any learning community. New members are welcomed by returning peers, faculty, and staff. Within the community, students work together to assist one another with personal and course related issues. As students take on additional responsibilities within the group and begin to care about and relate to one another on a deeper level they become invested in the learning community. Students see themselves as having ownership of the group. With this investment comes influence over the community. Students can influence one another through high expectations or rules within the community. When students begin to feel a true common purpose in the group, they take on the learning community as part of their identity. This identity is often expressed by symbols and referring to the learning community group as *we*. Schroeder acknowledged that these principles were not only sequential, but also cyclical in nature. A student would move through the stages one building into the other until identity was reached. At that point, the greater identity felt by a student the more involved in the community he or she would become, starting the cycle once again. When student interaction takes place, the learning community can be more effective in providing the desired outcomes and student benefits (Schroeder).

Benefits of Learning Communities

Retention, academic achievement, involvement, degree completion, and intellectual development are common student outcomes of learning communities (Lenning & Ebbers, 1999; MacGregor et al., 2002; Pascarella & Terenzini, 1991). Though these are often the most discussed, there are many underlying benefits of learning communities that lead to these outcomes. In most instances, peer pressure is not seen as beneficial. However, within a learning community students feel peer pressure to engage in learning and social activities, go to class (Tinto & Goodsell, 1993), and to study and participate (Gabelnick et al., 1990). They create their own support networks (Tinto, 1998; 2000a) where they learn from one another and form study groups (Gabelnick et al., 1990). Not only do learning community students spend more time learning together, but they also form social groups outside of class (Tinto, 2001). Friendships can be formed early in the first semester when they are critical to a student's survival at the institution (Upcraft, 1989a). The involvement experienced by students assists in easing the transition to college. Students in some curricular learning communities reported a greater sense of belonging (Smith et al., 2004). One key benefit to learning communities is that through peer interactions students can become socially and academically involved in the institution without the two areas having to compete with one another (Tinto, 2000a; Tinto & Goodsell, 1993). Because the learning community under investigation was grouped around an academic area, STEM, that required a great amount of academic focus and time spent studying, the notion of achieving both academic and social integration without competition for the resource of time was critical to its success.

Students perform at higher levels and are retained because they are engaged and active participants in the learning community (Gabelnick, 1997). They feel more connected to the campus and better understand connections within the curriculum than do non-learning community students (Laufgraben, 2005; Smith et al., 2004). There is a deeper faculty-student involvement in learning (Smith et al., 2004) and learning community students are significantly more likely to have stronger relationships with faculty which extend outside the classroom (Center for Student Studies, 2004). Ultimately, learning community students are often more satisfied with their overall experience of college than non-participants (Shapiro & Levine, 1999).

Institutions often look for opportunities to create environments that will assist commuter and underrepresented students to be more successful. Commuter students may have no other opportunity to become involved on campus (Tinto, 1998). Through the classroom portion of the learning community, commuter students can form support and study groups as well as make connections to residence hall students who can assist in connecting the commuter student to campus (Zeller, 2005). Discussions of diversity are important to minority and non-minority students alike. In their work *Diversity Works: The Emerging Picture of How Students Benefit,* Smith and Associates (1997) suggested several strategies for increasing the success of underrepresented populations in college. Among those were programs that assist in the transition to college and promote interaction between groups, mentoring programs, student support programs specialized for smaller groups, and campus community building activities. Many learning communities create and support these types of programs. Hotchkiss, Moore, and Pitts (2006) found in their investigation of a Freshman Learning Community (FLC) that increases in academic performance and retention varied due to ones gender and race. Only African American students participating in the FLC at a predominantly white institution saw an increase in retention one year after matriculation while white females experienced no benefits. The greatest impact in GPA was experienced by African American males and second by African American females who increased their first semester GPA by almost a letter grade and in the case of African American males, over one letter grade (Hotchkiss, Moore, & Pitts). These findings supported by the work of MacKay and Kuh (1994) and DeSousa and Kuh (1996) led the researchers to suggest that learning communities targeting African American males may cause even greater increases in their level of retention and academic performance.

As more students enter the education system and institutional sizes grow to accommodate the volume, ways must be found to replicate the benefits of smaller institutions. Large institutions have to work hard to accomplish what smaller institutions take for granted (Barefoot, n.d.a). Another significant benefit of learning communities is their ability to create smaller communities within a much larger institution. Astin (1997) and Tinto (1993) both stated that institutional size, among other items, had a potential negative effect on students during the first year. Withdrawal, already known to be frequent in the first year, was more likely at large institutions due to the isolation students may feel (Tinto, 1993). To combat the large institution size, researchers (Kuh & Love, 2000; Laufgraben, 2005; Lenning & Ebbers, 1999; Schroeder, 1994; Shapiro & Levine, 1999; Tinto, 1993; Tinto & Goodsell, 1993) suggested the creation of smaller communities, enclaves, or subgroups within the institution. Kuh et al. (2005) believed learning communities were the way to make this happen. The hope was that the desire to persist would develop from a relationship to one community within the institution (Tinto, 1993). Large institutions are harmful to the forming of peer groups (Smith et al., 2004) and the development of faculty-student relationships (Shapiro & Levine, 1999; Smith et al., 2004). The reduction of psychological size (Pascarella & Terenzini, 1991) of larger institutions occurs through “opportunities for students to become involved with smaller groups of individuals” (p. 654). Learning communities help to create a personal scale in which to develop these relationships. As an institutions size increases often so does its freshman course size. Participating in a learning community is one way to combat the size of the large classes. Students in learning community cohorts feel more comfortable in large classes because they know a significant number of classmates through the embedded cohort (Tinto & Goodsell, 1993). In the 2000 National Survey of First-Year Curricular Practices Summary of Findings, Barefoot (n.d.a) reported, "the percentage of these large institutions [research universities] offering programs designed to 'make the large university seem small' and create a greater sense of community is striking" (p. 5).

Not everything about a learning community is positive. Gabelnick et al. (1990) found that some students participating in curricular learning communities complained about the work load placed on them and the high levels of interaction required in the classroom. Students with these complaints that left the learning community typically had other external commitments with which they had to share their time or felt anxiety from speaking in front of their classmates. Some studies found that even though persistence increased for learning community participants, when background variables were controlled for the effect went away (Borden & Rooney, 1998; Gordon, Young, & Kalianov, 2001). Tinto (2000b) found that some students do not like learning with others. Participation in fraternities and sororities, which are often seen as learning communities, can produce negative effects on academic performance (Peltier, Laden, & Matranga, 1999). This is typically attributed to over socialization or increased alcohol consumption as Greek members have been found to have a greater use of alcohol than nonmembers

(Cashin, Presley, & Meilman, 1998). However, the social nature of the groups encourages loyalty and forms strong bonds which leads to increased persistence and graduation (Astin, 1975; Kuh, 2002; Moore, Loevell, McGann, & Wyrick, 1998; Trip, 1997). The positives of learning communities far outweigh the negatives even into future terms. Gabelnick et al. (1990) reported that participants of learning communities strived to be "re-creators of community wherever they go" (p. 74). In addition, participants continued study groups and relationships with faculty and registered together in future terms.

The benefits to implementing different types of learning communities on college campuses are great. A large portion of the past research on learning communities has centered on the curricular learning community setting (Gabelnick et al., 1990; Shapiro & Levine, 1999; Smith et al., 2004). As noted by the different types of learning communities, there are other aspects to be explored. Schroeder and Hurst (1996) believed the emphasis "on curricular structures and student-faculty interaction fails to take into account the importance of student-to-student interaction in the educational process" (p. 178). According to Boyer (1987), "even at large complex institutions…the goal should be to build alliances" (p. 191) where the classroom and out-of-class activities come together.

> When students are actively engaged in learning, whether through classroom instruction or through out-of-class activities, change is likely to occur. The research consistently shows that learning is bound neither by time nor by place, that is occurs continuously in a variety of locations, often unpredictably, and that it is maximized when both the activities and outcomes have meaning for the learner. (Pascarella & Terenzini, 2005, p. 645)

Involvement by students in these co-curricular aspects affects learning and the more students learn the more likely they are to stay in school (Levitz & Noel, 1989; Tinto, 1993). Learning communities are the alliances Boyer spoke of. In these programs, learning can be extended outside the classroom boundaries into the personal lives of the students. The *Student Learning Imperative* (ACPA, 1996) and *Returning to Our Roots: The Student Experience* (Kellogg Commission, 1997), among other studies, called for increasing links between students' in- and out-of-class experiences. These involvements in- and out-of-class have been shown to promote social and academic integration into the institution (Braxton, 2003) and, indirectly, retention. This investigation explored the relationship of the co-curricular aspects of the learning community. Specifically, the three areas of interest were the residence hall experience, the academic support center, and the social integration or involvement of students participating in the learning community. A more thorough review of the research on each of these areas was provided.

Residence Halls and Living-Learning Communities

Residence halls, formerly dormitories, have been a part of the American "college experience" since Colonial times (Schroeder & Mable, 1994b). Colonial colleges were not able to duplicate the successful efforts of their British counterparts due to the heavy load placed on faculty by the institutions. Rather than developing collegial relationships faculty spent their time enforcing rules and attending to the discipline of their students (Rudolph, 1990). As the German system, focusing on research and teaching, became a more prominent model in America, residence halls and other non-instructional activities were considered less a part of the intellectual life of the institution (Schroeder & Mable, 1994b). During the early to the mid-twentieth century, enrollments were exploding with the addition of women and blacks, extracurricular activities were on the rise, and new institutions were making their appearance, each contributing to the growth of residence halls. At this point, the emphasis of residence halls was on creating beds not educating students (Schroeder & Mable, 1994b). Student Affairs professionals were hired to oversee the areas outside the classroom which were no longer being monitored by faculty. Early programming efforts by residence life staff were more student development focused and not always relevant to the institutional mission. The student learning focus promoted during the late eighties and mid nineties (ACPA, 1996; ACPA & NASPA, 1997; Kellogg Commission, 1997; Study Group, 1984) helped residence halls become a partner in the learning process rather than a distraction (Boyer, 1987; Schroeder & Mable, 1994b).

Based on the 2000 Census figures, across the nation there were over 2 million students living in residence halls with the potential, as of 2004, for over 2.6 million to reside on campus (Association of College & University Housing Officers – International, 2007). Institutions continue to build residence halls not only to house the influx of students, but to enhance their college learning experience and increase their likelihood of graduation. Research has shown that residence halls increase retention and the social integration of students (Astin, 1975, 1977, 2006; Boyer, 1987; Braxton, 2003; Chickering, 1974; Christie & Dinham, 1991; Pascarella, Terenzini, & Blimling, 1994;

Pike, 1999; Skahill, 2003). Astin (1977) estimated a 12% net advantage to a student's chance of persisting by living in an on-campus residence. Astin and Oseguera's (2005) study investigating environmental influences on degree attainment supported the idea that residence hall living during the freshman year positively enhanced chances of graduation. This research supports the recommendation made by Braxton and McClendon (2002) that all first year students should be required to live on-campus. As reported in the 2000 National Survey of First-Year Co-Curricular Practices, a large number of four year institutions were already on their way in requiring first-year students live in residence halls (Barefoot & Siegel, n.d.).

Residence halls increase social integration and involvement by providing extended opportunities for a large number of students to interact with one another, have shared experiences, interact with faculty, and develop friendships (Pike, 1999; Pike, Schroeder, & Berry, 1997; Upcraft, 1989a). Researchers as early as Meiklejohn (1927) believed that the residence hall was critical to building community among students. Christie and Dinham's (1991) qualitative study testing the concept of social integration in the first year of college found that living on campus and participation in extracurricular activities were among the top of the most influential factors on social integration. More important, it was determined that living on campus assisted a student with integration into the social system in four ways: (a) "Meeting other students, (b) developing student friendships, (c) gaining information about social opportunities on campus, and (d) shifting away from high-school friends" (p. 419). According to Pascarella, Terenzini, and

Blimling (1994), the study of residence halls is based on the idea that the residence hall provides a positive, distinct environment from what one would experience living elsewhere. This advantage comes from the opportunities to be involved in on-campus activities. A residence hall students' proximity to campus activities allows for greater benefits (Hughes, 1994) due to the enhanced likelihood of participation. The benefits of social integration provide residence hall students with an increased satisfaction (Marchese, 1994; Pike, 1999) in their college experience and a smoother transition to the institution (Zeller, 2005). Residence halls support Tinto's (1993) idea that "smaller campus communities…play an important role in enabling newcomers to find an early physical, social, and academic anchorage during the transition to college life" (p. 125). Pascarella, Terenzini, and Blimling (1994) synthesized the literature and summarized the benefits of living in college residence halls over commuting.

1. Participate in a greater number of extracurricular, social, and cultural events on campus
2. Interact more frequently with faculty and peers in informal settings
3. Are significantly more satisfied with college and are more positive about the social and interpersonal environment of their campus
4. Are more likely to persist and graduate from college
5. Show significantly greater positive gains in such areas of psychosocial development as autonomy and inner-directedness, intellectual orientation, and self concept
6. Demonstrate significantly greater increases in aesthetic, cultural, and intellectual values, social and political liberalism, and secularism (p. 39).

The influence of living in a residence hall is not always clear nor is it always positive. Self-selection is an issue which plagues research on environmental impact (Andrade, 2008; Hotchkiss, Moore, & Pitts, 2006; Pascarella, Terenzini, & Blimling, 1994; Zheng, Saunder, Shelley, & Whalen, 2002). Students choose to live off-campus or in a particular residence hall on-campus therefore, it is difficult to differentiate between the environmental impact and the individual student traits that lead them to make a specific choice. Additionally, entering students who choose to live on-campus have been shown "to enter college with traits that make them more likely to persist and graduate to begin with" (Pascarella, Terenzini, & Blimling, 1994, p. 27). These confounding variables make it difficult to establish cause-effect relationships. Outcomes of residence hall effect on academic achievement have been mixed (Pike, Schroeder, & Berry, 1997). Researchers have used different measures of academic or intellectual achievement. In a review of the literature, Pike (1999) reported that Hood (1984) found no significant difference in cognitive complexity for students living on-campus and Winter, McClelland, and Stewart (1981) reported a negative relationship with critical thinking. Inman and Pascarella (1998) reported no significant difference in ability of students living on-campus while Chickering (1974) reported more involvement in academic activities and higher grade point averages. Blimling's (1989) meta-analysis led him to report that once precollege abilities were taken into consideration, residence halls had no advantage or disadvantage on academic performance. In another study, when controlling for precollege differences, residence hall students had slightly higher critical thinking scores (Pascarella et al., 1993). Other research reported that academic achievement and student learning were enhanced by the residence halls (Kuh et al., 1991; Pascarella & Terenzini, 1991) and that greater levels of academic achievement were found in residence halls that had a more academic orientation (Pike, Schroeder, & Berry, 1997). Living-learning communities have grown from the success of residence halls and are the result of attempts to create a more academically oriented environment where students continue their learning outside the classroom.

Living-learning communities. In assessing the traditional residence halls, which have proven to be a valuable resource to enhancing the education of students, Schroeder (1994) identified three limitations. First, traditional residence halls focused on the staff and their interests, not the students. Second, very little control of the environment was invested in the students, limiting opportunities for community building and personal development. Lastly, the traditional model focused attention on the individual student not on group peer interaction which is known to enhance community, involvement, and retention. Researchers believed that learning could occur in *intentionally* designed residence halls (Schroeder, 1994; Terenzini & Pascarella, 1994). The call for institutions to become more intentional about educating students forced colleges and universities to reassess their on-campus living environments. Levine (1994) suggested institutions consider four things if they wanted to be intentional about educating students: (a) education outside the classroom on residential campuses is powerful, (b) students teach students, (c) in relation to campus life, students create and teach each other standards, and (d) student-initiated activities are best.

A residential or living-learning community is “an intentionally developed community that will promote and maximize learning” (Lenning & Ebbers, 1999, p. 8) in a residence hall environment. As with learning communities, the structure of living-learning communities varies across institutions. Some living-learning communities are paired with linked classes or are linked with student support services, where others house classes and faculty in the residence hall environment (Upcraft, 1989a). Smith et al. (2004) described living-learning communities as learning communities that “restructured the residential environment to build community and integrate academic work with out-of-class experiences” (p. 20). Astin (1993) suggested that if residence halls wanted to be learning environments they must exemplify the following: (a) student-to-student interactions, (b) faculty-to-student interactions, (c) study environments and time devoted to studying, (d) opportunities for altruism, social activism, and social engagement, (e) promotion and discussion with others of diversity and racial/ethnic issues, and (f) mentoring and tutoring between students (Zeller, 2005). How the residence hall environment is structured is critical to the success of a living-learning community. Who students live with, where they live, and what they do in these environments influence student learning (Whitt & Nuss, 1994). As early as 1971, Taylor, Roth, and Hanson suggested that students should be grouped in the curriculum and in the residence halls so a common interaction could take place out-of-class that would enhance learning. To create living-learning communities students must be assigned to the residence hall with some purpose, in a way that encourages a sense of community (Braxton & McClendon, 2002) and fosters the development of affinity groups (Braxton, Brier, & Steele, 2008). These "*purposeful, programmatic* efforts to integrate students' intellectual and social lives during college" (Terenzini & Pascarella, 1994, p. 32) are the residential environments with the strongest influence on learning and persistence.

Living-learning communities are more educationally powerful than traditional residence halls. Pascarella, Terenzini, and Blimling (1994) reported five areas, supported by empirical evidence, where living-learning communities provided more benefits than their traditional counterparts: (a) informal faculty interaction, (b) satisfaction with the social atmosphere in the residence hall, (c) intellectual stimulation in the residence hall, (d) academic performance, and (e) persistence and graduation. These were supported by additional findings of increased faculty-student and student-student interaction (Center for Student Studies, 2004; Pike, 1999; Pike, Schroeder, & Berry, 1997), greater gains in learning (Pike), higher levels of critical thinking skills and GPAs (Center for Student Studies; Noble, Flynn, Lee, & Hilton, 2008), and an improved time to degree (Noble et al.) for living-learning community participants. The Center for Student Studies (2004) reaffirmed the supportive academic and social environment found by Pascarella et al. (1994). Living-learning communities provide a place where the social and academic aspects of a first-year student overlaps (Laufgraben, 2005; Tinto, 2006) and involvement (Pike, 1999; Inkelas & Weisman, 2003) is increased. The social and academically integrated and more supportive environment of the living-learning community allows for a smoother transition in the first-year and increased communication among peers (Brower, 2007; Tinto & Goodsell, 1993).

Why do living-learning communities increase student gains over a traditional residence hall? Whether it is called social integration (Tinto, 1993), involvement (Astin, 1999), or engagement (Kuh et al., 2005), the amount of psychological and physical effort students put into their college experience is what influences outcomes (Astin, 1999; Inkelas & Weisman, 2003). In *What Matters in College? Four Critical Years Revisited* (1993), Astin identified the three forms of involvement with the most influence on student outcomes: (a) academic involvement, (b) involvement with faculty, and (c) involvement with student peers. These three types of involvement, with their importance supported throughout the literature (Astin, 1996; Astin & Oseguera, 2005; Bean, 2005; Braxton, 2003; Cuseo, n.d.; Gabelnick et al., 1990; Kuh, 2002; Kuh et al., 2005; Milem & Berger, 1997; Pascarella & Terenzini, 1991, 2005; Reason, Terenzini, & Domingo, 2006; Tinto, 1975, 1993, 2000a; Upcraft, 1989a), are what most living-learning communities are based on. The purpose of a living-learning community is to integrate the curricular and co-curricular aspects of a student's life or, more simply put, to bridge the gap between students' in-class and out-of-class activities (Pike, 1999). Though important, the residential component of this living-learning community is only one piece of the co-curricular puzzle. The learning community under investigation embodies the principles of a living-learning community in its attempt to increase faculty-student, student-student, and academic involvement in a residential setting. In addition to providing out-of-class connections in the residence hall, the EXCEL program provides the Center, a separate space for further interactions between students and faculty.

Support Centers

Research calls for creating safe, shared spaces (Kuh et al., 2005; Laufgraben, 2005; Smith et al., 2004; Zheng et al., 2002) where students and faculty can informally come together outside of class to enhance learning. One such space is an academic support center. Another possible co-curricular component of a learning community, the academic support center design varies by institution and program. Some programs may be established within the residence hall and others in separate on-campus locations. Regardless of placement, there are certain functions this component of the learning community performs.

Time on task is important to the success of students (Welty, 1994). Student and faculty understandings of what is expected in the classroom do not match (Kuh, 2003; Smith et al., 2004). Students, especially those in the first year, spend less time studying than educators believe is necessary to succeed (Kuh). Due to this mismatch in expectations and the fact that students in trouble tend to not seek assistance (Cuseo, 1991), more intrusive efforts must be employed by institutions. An academic support center provides a space where students are encouraged or even required to spend more time on the task of studying. Learning communities are successful because they create environments that encourage students to study together (Zheng et al., 2002). Peer and academic involvement, both accomplished through students studying together, are two of the most potent types of involvement (Astin, 1993) in which students can participate. Tutoring is another service that plays a role in the retention of students (Braxton, Brier, & Steele, 2008) and can be provided in academic support centers. In the preliminary findings of the 2008 National Survey of Student Success and Learning Centers conducted by the National Resource Center for the First-Year Experience and Students in Transition (2008), tutoring was found to be overwhelmingly the most used service by students. In their research on experimental housing and tutoring, Taylor, Roth, and Hanson (1971) quoted Lindgren (1968) when they described the positive impact of tutoring as being important not only for the instructional assistance that was provided, but also for the immediate feedback, motivation, and reinforcement that students received. The latest findings of The National Study of Living Learning Programs reported that students who received tutoring experienced an improved social transition to the institution and an increased sense of belonging (Brower, 2007) both important outcomes of a first-year learning community.

An academic support center allows institutions to follow through with two of the recommendations put forth by Braxton and Mundy (2002) that assist in reducing college student departure. First, as part of a supportive learning environment, the academic support centers are places that can assist in promoting “student awareness of and access to appropriate co-curricular programs and resources…that connect and support students in their incorporation into the university community” (p. 92). Second, they “provide specific services…and address student concerns…to foster students' perceptions of the institution as supportive and caring" (p. 93). Academic support centers as a part of a learning community provide an opportunity for delivery of community based support services (Laufgraben, 2005). Here services can be tailored to meet the specific needs of the community. All levels of students within the community can benefit from the academic support provided, not just those students at-risk. Academically talented, as often as the average students, come in lacking in learning skills. Some study too much and others not enough (Walter, Gomon, Guenzel, & Smith, 1989). Additionally, to meet the needs of all students within the community, service formats must be flexible and work with the students' schedules (Walter et al., 1989).

The importance of academic support centers for retention lies within providing these intentional and intrusive resources within the first-year when students need them most (Cuseo, 1991; Kuh et al., 2005; Levine, 1994; Mortenson, 2005; Tinto, 1982, 1998). Incorporating the services of an academic support center into a living-learning community meets both the goal of early intervention and the goal of enhanced student learning through integration of curricular and co-curricular activities. The literature encourages institutions to provide academic support that compliments what is taking place in the classroom (Braxton, Brier, & Steele, 2008) through activities such as tutoring (Brower, 2007; Tinto & Pusser, 2006; Whitt & Nuss, 1994), study groups (Tinto & Pusser), intrusive advising (Noel-Levitz, 2008a), learning skills training (Ryan & Glenn, 2003), and supplemental instruction (Tinto & Pusser). When the co-curricular is linked to the classroom, the entire campus becomes a place for learning (Boyer, 1987).

Because performance in courses during the first year influences persistence (Nora, Barlow, & Crisp, 2005; Pascarella & Terenzini, 2005), students must be challenged academically by setting high standards and then provided the necessary support to reach these goals (Kuh et al., 2005).

> *Students learn more when they are intensely involved in their education and have opportunities to think about and apply what they are learning in different settings. Furthermore, when students collaborate with others in solving problems or mastering difficult material, they acquire valuable skills that prepare them to deal with the messy, unscripted problems they will encounter daily during and after college.* (p. 193)

Learning communities that include academic support centers provide the settings and the opportunities necessary for students to work together and become more involved in their education. Success through good grades during the first year enhances the academic integration of students and is important to their future academic success and degree completion (Pascarella & Terenzini, 2005).

A final important aspect of the academic support center is the opportunity to serve different groups within the learning community. Though residential students have many opportunities and spaces where they can go to connect to each other and campus, commuter students participating in learning communities are often limited in their options. Commuter students need places they can go between classes (Boyer, 1987) to relax or study. The academic support center provides commuters with a place to study on-campus and an opportunity for them to connect to campus (Zeller, 2005). It is important to provide these places where commuting students can receive similar social integration experiences as those experienced by students who live on campus (Braxton & McClendon, 2002). The academic support center becomes a place where commuter students cannot only meet with study groups and receive tutoring, but also develop a social environment where they can interact and form relationships with students and faculty (Braxton & Mundy, 2002; Zeller, 2005). Interaction with faculty and peers are two of the most important types of involvement students can experience (Astin, 1993). Combine this with interactions around academics and institutions have fulfilled the three types of involvement Astin believed to have the most influence on student outcomes. An academic support center as part of a learning community provides the catalytic space where this involvement can take place for residential as well as commuter students. Through this involvement students become socially and academically integrated into the learning community. Expansion on the concept of social integration was important to this investigation as its focus laid within the co-curricular aspects of the learning community.

Social Integration

Student involvement in the academic and social systems of the institution is critical for persistence (Pascarella & Terenzini, 2005) because higher levels of integration equal a greater commitment to the institution (Seidman, 2005). Learning communities are avenues for fostering both academic and social integration (Lenning & Ebbers, 1999). Tinto (1993) believed that an individual's social and academic integration into the institution was what most directly influenced the decision for continued attendance. With only modest empirical support found for the influence of academic integration on a student's commitment to persist (Braxton et al., 1997), Braxton insisted that academic integration was not a reliable influence on a student's decision for voluntary departure (Braxton, 2003). Tinto's (1993) theory argued for some, not full, integration into one or both of the academic and social systems for persistence to exist. However, without some minimal level of academic performance students may be required to involuntarily leave the institution. As shown by Pascarella and Terenzini (2005), good grades during the first year lead to future student success and graduation. Though social integration is a better predictor of persistence, it is important to not discard academics as part of the activities of learning communities. As most retention efforts are non-academic and have little faculty involvement (Tinto, 2001), learning communities with an academic focus allow for increased interactions with the faculty and potentially a better faculty understanding and support for retention efforts. Additionally, student involvement in the academic system enhances their social as well as academic integration.

Social integration "represents the extent to which a student finds the institution's social environment to be congenial with his or her preferences" (Kuh, 2006, p. 9). Supporting previous research (Tinto, 1993, 2001), Beil et al. (1999) found that social integration into the institution early during the first year is more important than academic integration and as students progress into their college careers, academic integration becomes the greater focus. Students have a tendency to leave, especially during the first year, due to lack of social integration caused by a lack of congruence or feelings of isolation and loneliness (Tinto, 1993, 2001). Students are unable to establish the necessary connections. Attinasi (1992) believed social integration was important because it helped students establish these connections by meeting individuals who could assist them in navigating the various campus "geographies" (p. 67). Isolation which leads to a lack of social integration and other negative effects is more likely to occur at large institutions (Pascarella & Terenzini, 2005; Tinto, 1993). Because students can be invisible in large institutions, it is more difficult for them to get involved (Kuh et al., 2005). Within large institutions, students often search out smaller subcultures with which to affiliate. Tinto (1993) and others (Kuh, 1994, 2002; Kuh et al., 2005; Kuh & Love, 2000; Laufgraben, 2005; Schroeder, 1994; Schroeder & Hurst, 1996; Shapiro & Levine, 1999) believed that involvement, and subsequently social integration into the institution, could occur at this subgroup level. Connecting with these affinity groups (Kuh, 1994), microenvironments (Schroeder & Hurst, 1996), subcultures (Kuh, 2002; Tinto, 1993), or enclaves (Kuh & Love, 2000) reduces the psychological size of the institution and increases the likelihood of meaningful involvement, social integration into the institution, and persistence into the future (Kuh, 2002; Kuh et al., 2005; Tinto, 1993). Large institutions must work hard to create smaller communities in order to achieve the size advantage of smaller institutions (Barefoot, n.d.b; Lenning & Ebbers, 1999). Learning communities are one strategy by which institutions can attempt to reduce the psychological size of an institution, by creating a personal scale for students and faculty (Shapiro & Levine, 1999), and increase social integration. Learning communities accomplish social integration through increased informal student-faculty interactions, integration of curricular and co-curricular activities, and the composition of cohorts within which students can establish friendships and support networks through increased student-student interactions. These activities support Astin's (1993) three types of involvement important to enhancing student outcomes and Braxton, Hirschy, and McClendon's (2004) recommendation that institutions create environments that foster involvement. Because each of these activities played an important part in the learning community under investigation a synopsis of the related literature was provided.

Student interaction with faculty. Research supporting the positive influence of faculty-student (Andrade, 2008; Cuseo, 1991; Kramer & Spencer, 1989; Laufgraben, 2005; Levitz & Noel, 1989; Milem & Berger, 1997; Pascarella & Terenzini, 1980b, 2005; Shapiro & Levine, 1999; Terenzini & Reason, 2005; Tinto, 2000, 2007) and student-student (Astin, 1993; Astin & Astin, 1992; Bean, 1985; Braxton, 2003; Chickering & Reisser, 1993; Kuh, 2002; Milem & Berger, 1997; Nicpon et al., 2007; Pascarella et al., 1996; Pascarella & Terenzini, 2005; Tinto, 1975) interaction on persistence and other student outcomes is overwhelming. Supported by Astin's (1999) involvement theory and Tinto's (1993) theory of college student departure, learning communities increase social integration by creating environments that foster these positive interactions. Levitz and Noel (1989) believed that the most important step to connecting freshmen to the college environment was to make sure they were connected to at least one individual at the institution. "All freshmen should have the sense that someone at the institution knows them personally and cares about their academic and personal well-being" (p. 72). Pascarella and Terenzini (1980a) found strong support for a relationship between persistence and frequent student-faculty interactions. Persisters scored one standard deviation higher on faculty interaction and concern for student scales than did students who voluntarily withdrew at the end of the first year. These findings helped to underscore the importance of both informal and formal student-faculty contact. Milem and Berger (1997) found that students' early involvement with faculty played a significant positive role in persistence. They believed more time should be spent connecting freshmen with faculty rather than waiting for these interactions to occur later in the student's academic career. Their results confirmed the findings of Pascarella and Terenzini (1980a) that these interactions should occur both in and out of the classroom.

Student-faculty interaction begins in the classroom. Levitz and Noel (1989) stated that to benefit freshmen learning and their greater likelihood of staying, institutions should assign their best teachers to first-year classes. Cuseo (1991) supported this idea by suggesting institutions assign their best faculty to freshman courses. The Foundations of Excellence® in the First College Year Project (2005) suggested that institutions that hoped to be effective in promoting first-year student success make the first-year a high priority for faculty. Unfortunately, institutions continue to assign their least experienced and typically least connected faculty to the first-year courses (Tinto, 2007). Learning communities often bring high quality instructors into the first-year and promote collaboration among faculty and courses (Shapiro & Levine, 1999). In addition, a number of first-year courses are large lecture sections. Harrison (2006) in a study of first-year undergraduate withdrawal found that students entering with non-traditional qualifications left due to dissatisfaction with the size of their cohort group and the lack of personal interaction with the faculty. In his synthesis of the literature on large class size, Cuseo (2007) identified seven negative outcomes. Of importance to this investigation was the finding that "large class size reduces the frequency and quality of instructor *interaction* with and *feedback* to students" (p. 5). Students in these classes experienced high levels of dissatisfaction due to the lack of faculty interaction. With larger class sizes and less experienced faculty, it is no surprise that students report being disengaged from their coursework and intimidated by professors during the first year of college (HERI, n.d.). Learning communities that include smaller first-year courses as part of the curriculum promote a better environment for student-faculty interaction to take place inside the classroom. Students in learning communities are more involved in the classroom and are more likely to reach out to faculty outside the classroom (Tinto, 2000a). Out-of-class contact with faculty is linked to higher levels of retention and degree completion (Pascarella & Terenzini, 2005; Tinto, 2000a), educational attainment, sense of fit, satisfaction, and commitment to the institution among other student outcomes (Bean, 2005; Golde & Pribbenow, 2000). Over 50% of the institutions who participated in the 2000 National Survey of First-Year Curricular Practices reported intentional efforts to increase the faculty-student out-of-class contact during the first year (Barefoot, n.d.a). In Andrade's (2008) synthesis of learning community studies, she reported on the important role faculty played. Faculty who cared, had the ability to motivate, and showed respect for students participating in the learning community were characteristics critical to students' willingness to take risks in class and seek assistance from faculty (Baker & Pomerantz, 2001). Crissman (2001) found students in the learning community were more comfortable, had more positive interactions, and were more likely to approach faculty than non-participants. According to Pascarella and Terenzini (2005), some studies found that students' perception of faculty being available and showing interest was enough to influence persistence. The influence came from the student's perceived interest of the institution in the student's welfare (Tinto, 1993). Research shows that learning community students value interaction with faculty (Laufgraben, 2005). The out-of-class faculty-student interaction provided by a learning community extends the academic conversation past the classroom environment into the residence hall, dining room, academic support center, or the social venue. The extension of these academic conversations is what most influences persistence (Cuseo, n.d.). The presence of faculty-student interaction cannot guarantee persistence, but the lack of interaction between these groups "almost always enhances the likelihood of departure" (Tinto, 1993, p. 117). Tinto (2001) suggested learning communities were the "most promising" (p. 5) reform for involving faculty and academics in institutional retention efforts. To increase retention, institutions must do what they can to encourage these types of interactions early in the student's tenure at the institution by involving faculty with students both in- and out-of-class (Tinto, 2001; Braxton et al., 2008).

Student interaction with peers. Tinto (1975, 1993) encouraged informal peer groups as part of the social integration process. Astin (1993) stated that "*the student's peer group is the single most potent source of influence on growth and development during the undergraduate years*" (p. 398). In an effort to enhance student development, institutions must encourage friendships and student communities in addition to frequent student-faculty relationships (Chickering & Reisser, 1993). Early involvement with peers (Milem and Berger, 1997) has a significant positive effect on student perceptions of institutional and peer support and on a student's level of institutional commitment. Berger & Milem (1999) confirmed these findings and reported that early involvement had significant effects on social and academic integration. Those students not involved early were "less likely to become integrated, and as a result, less likely to persist" (p. 658). Peer support and involvement positively influence the social integration of students (Braxton, 2003). This peer involvement occurs through students studying and socializing together and classmates talking to one another outside of class (Berger & Milem, 1999; Milem & Berger, 1997). These interactions increase the opportunities for the development of support networks and the formation of friendships (Braxton & McClendon, 2002; Tinto, 1975). Bean (2005) identified social support and close friendships as the two key components of social integration. From their synthesis of research over the last 30 years, Pascarella and Terenzini (2005) found that peers are the agent of socialization on campus with whom involvement is most important. This peer interaction was the most influential factor in student persistence. Two contributing dynamics were students being drawn to others like themselves and their likelihood to conform their values and goals to that of the group (Pascarella & Terenzini).

Learning communities provide the opportunity for peer interactions to take place. Tinto's (2006; Tinto & Goodsell, 1993) research on learning communities reinforced the positive nature of the peer group on learning and persistence. The proximal peer group, those individuals with whom one directly interacts over an extended period of time (Kuh, 2002), is believed to exert more influence over an individual than other peer influences. This group helps determine how a student spends their time. By developing a cohort of students who go to class, study, and live together, the learning community establishes a proximal peer group and an environment where students learn from one another through formal and informal contact in- and out-of-class and persist at the institution. Cohorts formed around courses and residence halls allow students to form self supporting networks and spend more time together outside of class (Tinto, 2001). Students in cohorts are more accountable to one another and their interaction reinforces the characteristics necessary to succeed in the group (Shapiro & Levine, 1999). Other benefits of peer group interaction include improved class attendance, adjustment to the institution, retention, and the encouraging of students to work together to solve problems. Additionally, learning communities are one approach institutions can implement to meet communal potential (Braxton et al., 2008). This is especially true at large institutions where the sheer size of the university hurts the positive formation of peer groups (Smith et al., 2004). Communal potential is one antecedent to social integration (Braxton & Hirschy, 2005).

Out-of-class activities. Students spend the majority of their time outside of class and it is what they do during this time that shapes their experiences (Boyer, 1987; Kuh, 1995b). Boyer believed "that the effectiveness of the undergraduate experience…is directly linked to the time students spend on campus and to the quality of their involvement in activities" (p. 191). Quality involvement in out-of-class, or co-curricular, activities is a contributing factor to the social integration of students (Astin, 1996; Pascarella & Terenzini, 2005; Tinto, 1992, 1993). However, excessive time spent on this type of activity can lead to too much social integration. Unless a balance can be struck with the academic orientation, students may be involuntarily dismissed from the institution (Tinto, 1975, 1993). Residence halls, especially as part of a living-learning community, provide one of the greatest opportunities for integration of in- and out-of-class experiences (Schroeder & Mable, 1994b; Zeller, 2005) and the facilitation of social integration (Christie & Dinham, 1991; Pascarella & Chapman, 1983). In addition to participation in residence halls and academic support centers, membership in clubs and organizations, attendance at cultural or academic programs on campus, and participation in internship or research opportunities are all types of co-curricular activities. These activities were often seen as extras rather than part of the educational experience (Upcraft, 1989b). As more researchers called for tying learning and the curriculum to students' out-of-class activities (Braxton & Mundy, 2002; Laufgraben, 2005; Nora, 2002), co-curricular experiences began to play a more important role. Braxton and Mundy (2002) recommended that institutions deal with the "holistic development" (p.

113) of students through attention to growth and learning in both the academic and greater university community.

Benefits similar to what have been discussed in regards to residence halls and support centers can be found in participation in other co-curricular activities. Participation in co-curricular activities increase the likelihood of persistence (Pascarella & Terenzini, 2005), degree completion (Pascarella & Chapman, 1983), institutional satisfaction (Barefoot & Siegel, n.d.) and positively influence learning and development (Kuh, 1993, 1995b; Kuh et al., 2005; Pike & Killian, 2001). Because students benefit more when they spend time on *educationally purposeful activities*, institutions have the responsibility to intentionally create multiple opportunities for involvement (Kuh, 1994). The greatest impact of involvement in co-curricular activities is when they come together with a student's academic activities to meet an educational outcome (Pascarella & Terenzini, 2005). However, these benefits can only be seen if students take advantage of the opportunities presented to them outside the classroom (Reason et al., 2006). Barefoot and Siegel (n.d.) argue that co-curricular activities have a greater impact during the first year when students most need the connection to the institution and are open to the positive influence. Learning communities provide formal and informal opportunities for students to become involved in educationally purposeful activities outside the classroom. Students can connect out-of-class by studying together, forming or joining organizations, participating in workshops or field trips offered by the learning community, or simply by conversing via e-mail or listserv (Laufgraben, 2005). In addition, students can become involved in other university sponsored activities external to the learning community.

The first section of the literature review provided a background on the broad topic of retention, the various strategies that could be used to retain first-year students, the different types of learning communities, and the co-curricular aspects of the learning community of interest to this investigation. With an understanding of the theoretical foundations for the EXCEL program, the remainder of the literature review was dedicated to why retention is important for the disciplines of science, technology, engineering, and math (STEM), what we know about STEM retention and learning communities, and the concept of psychological sense of community and how it is important in a university learning community.

The Study of STEM

Though the study of science, math, agriculture, and engineering took on a greater significance in the late 19th and early 20th centuries (Thelin, 2004), the beginnings of intense pressure to produce more students educated in the STEM disciplines came to the forefront with the 1957 launch of Sputnik. Americans were stunned. Government responded with a call to increase efforts in science and engineering research and education. America's success, evidenced not only by the great scientific achievements since that time, could be seen in the number of bachelor's degrees awarded in the STEM disciplines. In 1966, the first year for which the National Science Foundation (2008) reports data, 20% of all bachelor's degrees awarded were in the hard sciences.

Unfortunately, the interest could not be sustained and the percentage of bachelor's degrees awarded in the hard sciences fluctuated throughout the next 40 years reaching a high of 21% in the mid 1980s and a low of 15% in the early 1990s. Since the low in the 1990s, the percentage of STEM degrees in the hard sciences awarded has clustered around 16-17% of all degrees earned with the 2006 reports coming in at 16% (NSF, 2008).

During this period of fluctuation, the concern for undergraduate education in the STEM disciplines has continued. Numerous reports (Augustine, 2007; National Academies, 2007; National Science Board [NSB], 2008a, 2008b; Project Kaleidoscope, 2002, 2006) were, and continue to be, written by government, business, and academe to reinforce the need for coordinated action in improving undergraduate STEM education. In addition to reports requesting a national call to action, numerous committees and task forces have been established to further study and implement change initiatives geared at improving undergraduate STEM education in the U. S. These reports and task forces have typically served to accentuate one of the two major agendas in this national debate: increasing the number of students choosing and graduating in STEM disciplines or increasing the math and science literacy of all Americans (Schneider, 2008). Though increasing the number of STEM graduates was the foundation of this investigation, a review of the literature would not be complete without touching on both of the national agenda items.

The National K- 12 Agenda

In today's global economy, competition is fierce. America is concerned about its economic sustainability and continued international leadership. The nation's advantage is slipping in key indicators such as research and development (R&D) expenditures, world gross domestic product (GDP) shares, and trade and manufacturing of high-technologies (NSB, 2008c). Now, more than ever, the connection between science and competitiveness are evident. To keep our competitive advantage or at least hold our own in the global market, America must be able to compete in today's "knowledge-intensive" (NSB, 2008c) economy. Those that have the knowledge influence the growth of innovation. This calls for a better understanding of STEM concepts at the level of higher education and how those concepts affect all disciplines of study, not just those training future scientists and engineers (Berger & Lyon, 2005). However, science and mathematics literacy of all must begin earlier than college.

To accommodate this need, the agenda on educational reform shifted in the 1990s to include educating all students in science and mathematics (Seymour, 2002). The hope was to prepare a more scientifically literate workforce for the future and possibly encourage more students to enter the STEM pipeline along the way. As early as 1986, national reports (NSB, 1986) called for the collaboration between industry, government, institutions of higher education, and K-12 to educate students who would be able to make decisions on technical issues based on their knowledge of science and mathematics. National leaders called for investment in and support for postsecondary faculty to reform

STEM curriculum (NSB, 1986; NSF, 1996; Project Kaleidoscope, 1991; Watson, Bozeman, Nijhout, Mintzberg, & Willenbrock, 1989), to create supportive learning environments (Bransford, Brown, & Cocking, 1999; NSF, 1996; Watson et al., 1989), and to prepare K-12 teachers through deep immersion in math and science content (Project Kaleidoscope, 1991; U. S. Department of Education, 2000). Later reports reinforced the nation's previous recommendations for enhancing K-12 education (Business Roundtable et al., 2005; Council on Competitiveness, 2005) and emphasized new initiatives such as bridging the pathways between levels of education from grade school to graduate school (BEST, 2003), engaging faculty, making education more interactive (Business – Higher Education Forum [BHEF], 2003), and establishing a national STEM content for each grade level (NSB, 2008a).

The importance of educating students in math and science was not new to the national debate. The flurry of reports over the last two and half decades (e.g. *Innovate America, Tapping America's Potential, The Talent Imperative)*, however, did shift the focus to all students rather than those gifted in the areas of science and mathematics. Success in the early grades, but an inability to sustain learning increases through to college was evident in the statistics on national math and science scores. Fourth graders increased their performance in math and science from 1990 to 2005 while eighth graders showed improved performance only in math (NSB, 2008c). The proportion of students reaching the math proficiency level for their grade increased 23% for fourth graders and 15% for eighth graders during the same period. These results were consistent across gender and race. Regrettably, despite increases, that percentage of students meeting grade proficiency in math at both grade levels still falls well below 50%. The more distressing news comes at the high school level. A decline in average science scores and the proportion of those meeting the science grade proficiency level for twelfth graders was noted during the period from 1996 to 2005 (NSB). In 2003, American 15-year-olds competing in the Programme for International Student Assessment (PISA), an international exam that measures the ability to apply math and science concepts, scored below the international average (Lemke et al., 2004). Achievement gaps between racial/ethnic groups that were evident in kindergarten continued to exist. However, there were some small decreases in this gap between white and black students in mathematics and science at the fourth grade level and between white and black students in mathematics at the eighth grade level (NSB, 2008c). Other positives included students at the high school level taking more science and math courses, on average, and more courses at a higher level in these areas. This could help explain the slight improvement of students' readiness for college-level mathematics between 2003 and 2007. Unfortunately, even with improvements registered in recent years, still 57% of 2007 high school graduates tested by ACT were not ready to take a basic College Algebra course (ACT, 2008b). The study further reported that there were more students on track to be college ready in the eighth and tenth grade than were actually ready upon completion of high school, confirming findings from the *Science and Engineering Indicators, 2008* (NSB, 2008c). The National Science Board (2008a) bolstered the argument of students being underprepared when they reported that nearly 30% of students needed some remediation before studying math and science at the college-level. The importance of college readiness lies in the fact that students who are math ready are more likely to enroll in college directly following high school graduation and are more likely to persist to the second year (ACT, 2008b). Math teaches students how to think. This advantage to students was noted regardless of socio-economic status or race (Adelman, 1999). Astin and Astin (1993) believed that increasing science and math competency at the secondary level could increase the number of students pursuing a career in science or engineering. A need for vast improvement still exists if a scientific and mathematically literate population is to exist in America's future. Even with an emphasis on K-12 and educating all students in math and science, the conversation returns to the same place – preparing more students with a better understanding of math and science in the hopes of their integrating it into their career interests in college and perhaps increasing the number of interested students in the STEM pipeline.

The National Agenda: Calling for Change

Similar to the K-12 arguments, government and industry have spent the last 20 plus years informing institutions of higher education and their partners of what needs to be done fix the leaky STEM pipeline. Creating a stronger national K-12 education system that better prepares all students, regardless of race, socioeconomic status, or gender, in mathematics and science produces a more scientifically literate population. If interests are developed and nurtured early, then more students may stay in the pipeline through to college enrollment. Once there, institutional leaders must work with industry and government to do all that is possible to get students to progress to graduation. The Neal Report (NSB, 1986) called for states and industry to make undergraduate study of STEM a high priority. Other suggestions consistently published in reports were increasing access to diverse populations and creating a more interactive and engaging environment for study. The most prominent recommendation of the American Association for the Advancement of Science [AAAS] (Matyas & Malcom, 1991) report, *Investing in Human Potential,* called for feeding the pipeline by increasing the number of women and underrepresented minorities studying STEM. The report also suggested that institutions should look into barriers created by financial need and that academic departments should work on decreasing the lock-step nature of the coursework to allow more students to transfer into STEM disciplines. Assessment of access and the climate of the community were deemed important in determining where the leaks were occurring. Later, the National Science and Technology Council (2000) reiterated the charge of increasing the number of women and underrepresented minorities to ensure a strong STEM workforce. Their recommendation was to find ways to reduce barriers between levels of education and to encourage and reward partnerships between industry and institutions that fostered underrepresented student persistence in the field. Reports by the U. S. Commission on National Security (2001), the Business Roundtable et al. (2005), BEST (2003), the National Academies (2007), and the National Science Board (2008b) have continued to advocate increased access to women, underrepresented minorities, and students with disabilities.

Another popular recommendation was to change the way STEM undergraduate education was delivered. Two reports, both sponsored by the National Research Council (NRC & Center for Science, Mathematics, and Engineering Education, 1996; NSB & Government-University-Industry Research Roundtable, 1998), encouraged the use of undergraduate research to transform the approach to training future STEM professionals. Multiple, different types of research opportunities for students would allow them to prepare for the more flexible futures they were bound to experience and would teach the skills necessary for lifelong learning (NRC et al., 1996). Other reports (BEST, 2003; Business Roundtable et al., 2005; National Academies, 2007) repeated the importance of continuing research and involving the undergraduate STEM student in the process. The Business-Higher Education Forum (2003), though not geared solely toward STEM learners, called for the funding of a technology infrastructure that would allow learning to reach a larger population. In addition, the recommendations made were reminiscent of other reports: education in the skills for lifelong learning and challenging, interactive and engaging curriculum. Similarly, the Council on Competitiveness (2005) called for institutions to change teaching methods from a technical focus to one that fostered creative thinking and application. No longer was it acceptable to simply train people in the basic skills, the country needed workers with the ability to innovate.

Importance of STEM Retention

Hearing the call from industry and government, retention of STEM students has become a priority in higher education. Other than the typical call for institutional accountability and the desire to improve society with a more educated citizenry, there are some motivations for retention that are unique to the STEM population. First, America's future competitiveness in the global economy lies with the graduation and employment of the students currently in the STEM pipeline. Since the launch of Sputnik government and industry have espoused the necessity to graduate more students as scientists and engineers (BEST, 2003; Business Roundtable et al., 2005; Council on Competitiveness, 2005; National Academies, 2007; NSB, 1986, 2008b) in the name of remaining competitive. The number of first degrees earned in the natural sciences and engineering has traditionally been an indicator of a country's ability to innovate in the areas of science and technology (NSB, 2008c). There has been significant growth in the number of first degrees awarded by China and other Asian countries in recent years, wearing away America's advantage in innovation.

Other threats to the nation's economic competitiveness exist. A second reason for the importance of retention in undergraduate STEM programs is the opportunities available in other fields of study and the decreased interest in science and mathematics of students in America (NSB, 2008c). Because fewer students choose to enter the STEM disciplines, it becomes important to retain all those that do make the choice. For the last 20 years the proportion of students intending to enter the STEM disciplines has remained stable at about one-third of all entering freshmen (NSB). When taking a closer look at the numbers, one quickly sees that between 10 to 16% of this group intended to major in the social and behavioral sciences, not the hard sciences. This lowers the proportion of students intending to choose the STEM disciplines relevant to this investigation to approximately 23% of the total freshman class (College Board, 2007; NSF, 2006). Despite all of the efforts to increase the pipeline in STEM, not much has changed. On a positive note, the percentage of women, Hispanics, and American Indians increased during this same period (NSF; NSB, 2008c) more appropriately reflecting the changing demographics of the nation. Reflecting the changing demographic will be necessary to increase the number of STEM graduates in the future. In relation to the changing demographics, those in the fields of engineering and science have seen that it is important to make STEM career choices more attractive (National Academy of Engineering, 2005). Characterized for decades as competition-driven fields, STEM disciplines are looking for ways to attract more diverse types of students.

This necessary diversification leads to another motivating factor behind retention in STEM. A third concern lies in the fact that unlike a number of other disciplines, most college students cannot choose to major in a STEM discipline over night. Preparation for studying science, technology, engineering, or mathematics can begin as early as elementary, but definitely by middle and high school. Students are typically required to choose a track of study no later than the ninth grade. The track chosen will determine the type and level of classes completed during high school. Students not taking the appropriate math and science courses will be seriously disadvantaged in pursuing a STEM discipline in college. Once in college, the advanced calculus, physics, biology, and chemistry courses necessary for study in a STEM discipline can further serve as barriers to retention. Though difficult for students who are poorly prepared, success can be achieved with appropriate academic support from the institution. However, if students perceive these as “weed out” courses, which has been the interpretation for many, their performance suffers even more (Suresh, 2007). Poor performance in these “barrier courses” (Suresh, p. 216) leads students to switch to other majors that do not require completion of these courses. If the lower number of students choosing a STEM discipline, the extended timeline for math and science preparation, and the potential for serious barrier courses in the first year were not enough, the in-flow of transfers into STEM is minimal in comparison to the level of attrition. In a study conducted by Ohland, Sheppard, Lichtenstein, Eris, Chachra, and Layton (2008) using the Multiple-Institution Database for Investigating Engineering Longitudinal Development (MIDFIED), it was determined that students majoring in engineering, other science, technology, and math (STM), and computer science received lower migration into the disciplines than any other categories of majors. Engineering was by far the lowest with only seven percent of the graduates in that field having started their academic career in another major. The other STM and computer science fields received between 40 to 45% of their majors from other disciplines while other non-STEM disciplines received between 55 and 65% of their graduates from other disciplines. Explaining a large percent of the transfer into other

STM and computer science was the fact that a significant portion of this in-flow came from engineering or between the other STM and computer science fields.

Lastly, the motivation for graduating more students in STEM fields has not been only to increase the sheer number of scientists and engineers in the workforce, but to maintain the status quo and increase the jobs for others in the workforce (Augustine, 2007). Employment projections show the number of people employed in “professional and related occupations” (Bureau of Labor Statistics [BLS], 2007), the category which encompasses the majority of the STEM related career options, has continued to rise over the last decade. Though the projected percentage of growth for this category has consistently dropped during this same time frame, it continues to remain the largest projected growth market for occupations with 17% growth projected through 2016. Retirements are projected to increase within the next 20 years (NSB, 2008c). If degree production were to decrease, problems within the workforce could escalate. With that said, scientists and engineers only make up about 4% of the national workforce. The real importance of increasing the number of scientists and engineers is that they create jobs for others “by generating knowledge, by innovating, and by establishing new companies based on that knowledge and innovation” (Augustine, 2007, p. 41) and work to solve “other societal problems” (p. 41). America needs the next level of scientists and engineers – the innovators and the entrepreneurs.

Knowing that retention of STEM students is not only about increasing the number of people in the workforce and with all of the recommendations on how to fix the leaking pipeline one has to ask, where does STEM retention stand? Because of the mathematics and science preparation necessary to study in a STEM discipline, students are lost early on. Students begin kindergarten with gaps in mathematics learning. These gaps, based on race/ethnicity, socioeconomic status, and educational attainment of the mother, typically continue or widen throughout their academic career (NSB, 2008c). As previously discussed, gains in the fourth and eighth grades have occurred in the past decade, but have not fully translated through to the twelfth grade. Few students have the proper mathematics and science preparation to study STEM. For example, less than 15% of current high school graduates have the necessary preparation to begin to study in engineering (Augustine, 2007). These same credentials would be necessary to pursue a degree in science or mathematics.

Despite all of the efforts to encourage more students to enter the STEM pipeline, the percentage of students intending to enroll in the STEM hard sciences dropped over the last decade, but has hovered around 22% for the last two to three years (College Board, 2007). The drops occurred primarily in engineering and computer science with some gains in the biological and agricultural sciences (ACT, 2006; College Board; NSB, 2008c). This percentage is not spectacular when compared to the fact that business and health professions have 15% and 19%, respectively, of the intended enrollees and have maintained or increased their position over the last decade. The good news has been that within those who intended to enroll in STEM, the proportion of women and underrepresented minorities rose. As for the number of degrees awarded in STEM, though 22% of the students intended to enroll only 16% of the bachelor's degrees awarded in 2006 were in the STEM hard sciences (NSF, 2008). More disappointing was the fact that the proportion of STEM degrees awarded to women and key underrepresented minorities was lower than the national average (see Table 3).

Table 3.

Percentage of Degrees Conferred by Race and Gender in STEM Compared to the National Average: 2005-2006

Gender/Race	National average w/out STEM	STEM majors
Female	57	36
White	73	70
African American	10	7
Hispanic	8	6
Asian/Pacific Islander	6	11
American Indian/Native	.75	.7
Non-resident Alien	3	5

Source: U. S. Department of Education, National Center for Education Statistics, 2005-06 Integrated Postsecondary Education Data System (IPEDS), Fall 2006.

If students intend to receive a degree in STEM, but do not complete that degree, where do the problems lie? This investigation focused specifically on the first year. First-year retention for students attending public institutions has ranged between 70 to 74% for the last 20 years (ACT, 2008a). This percentage is made up of all students, including STEM, and only tracks a student's return to the institution, not retention within a specific major. Data for retention in a major are more difficult to access because most institutions, including UCF, only report institutional retention. Typically, national or average retention in a major would be determined in individual studies using large student databases like MIDFIELD that do longitudinal tracking of institutional data (Ohland et al., 2008). This information though better, still only represents a small sample of the national population and rarely reports first-year retention, instead opting for graduation rates. Therefore, comparisons between national retention data and STEM retention data, especially in the first-year, can only be used as general guides.

Since 1994, the Consortium for Student Retention Data Exchange (CSRDE) has worked to increase the national collection of data for more improved comparisons. The CSRDE reports retention to the second year of first-time, full-time baccalaureate seeking students both to the university and within the STEM disciplines. CSRDE data revealed that STEM students are retained in the major at a slightly lower rate than the national first-year retention rate reported by ACT, Inc., 71% compared to 74% at the same point in time (ACT, 2008a; Center for Institutional Data Exchange & Analysis [C-IDEA], 2008). When compared with the same CSRDE data set, the STEM retention is 71% to 81% for all freshman first-year retention. Discrepancies occur due to the number and breadth of participating institutions. Because the CSRDE data included private institutions the national ACT rate used in comparison was based on similar data. The University of Central Florida, the institution housing the program in this investigation, boasts a strong rate of first-year retention at the university. According to CSRDE data (C-IDEA, 2008), the institution retention rate for UCF was 84% placing the university slightly below the average of highly selective institutions which falls at 88%, but above the average of all institutions (81%). In reference to the STEM population, 67% of UCF STEM students were retained in the discipline after one year, well below the 77% one-year STEM retention rate for all highly selective institutions and slightly lower than the 71% all institution one-year STEM retention rate included in the data (C-IDEA, 2008). For the specific majors under investigation in this study, the UCF one year discipline specific retention rate in STEM is 68%. Exact data for one-year retention statistics for STEM students by gender and ethnicity were provided in Table 4 for the most recent year data was available.

Table 4.

First-Year Retention Percentages in STEM by Race and Gender Comparing EXCEL to UCF and the National Average: 2006-2007 Cohort Highly Selective Institutions

Gender/Race	National STEM		UCF STEM		EXCEL
	To institution	To STEM	To institution	To STEM	To STEM
Gender					
Male	88.4	78.8	82.3	72.7	86
Female	89.4	73.3	87.4	66.5	73.6
Race					
Black	87.5	72.3	82.6	70.6	100
Hispanic	86.1	73.3	83.2	69.4	87.9
American Indian	79.7	63.7	75	50	50
Asian	91.7	83.2	88.9	76.1	63.6
White	88.5	76.0	84.2	70.6	81
Nonresident Alien	90.3	84.0	--	--	--
Total	88.7	76.8	84	70	82.2

Source: Center for Institutional Data Exchange and Analysis (C-IDEA), Consortium for Student Retention Data Exchange, 2007-2008 CSRDE STEM Retention Report: Highly Selective Institutions, August 2008. University of Central Florida, Office of Institutional Research, Retention and Progression Reports, Cohort 2006-2007, June 2009.

How is STEM Retention Different?

Students in STEM disciplines face the same issues with retention as do students in other academic disciplines. Like others, STEM students struggle with academic and social integration, financial difficulties, transition issues, and external commitments. Like non-STEM students, background characteristics (Zhang, Anderson, Ohland, Carter, & Thorndyke, 2002) and first-year GPA and number of credits completed (Desjardins, Kim, & Rzonca, 2003) have been determined to be predictors of retention and graduation. One study found that engineering students, the STEM group expected to be the most divergent from other majors, were no different in engagement in or satisfaction with their major (Ohland et al., 2008). However, differences between students in STEM majors and other majors do exist. For example, one investigation reported STEM students persisting in the university at higher rates though not specifically in the STEM disciplines (Fenske et al., 2000). This research finding is consistent with one of the critical issues of STEM retention. STEM students do not persist within the STEM disciplines as well as they do within the university. Institutions must incorporate strategies to keep these students in the STEM disciplines and must find ways to track retention to the discipline rather than university level.

There are even differences within the individual STEM disciplines. There are fewer women in engineering (Zhang, Thorndyke, Rufus, Anderson, & Ohland, 2002). The number of women increases in other science disciplines and doubles for non-science disciplines. Within STEM, women earned bachelor's degrees at the rate of 51% in agricultural sciences, 62% in biological sciences, 52% in chemistry, 22% in computer science, 21% in physics, and 20% in engineering (NSB, 2008c). One multi-institution study found that STEM students changed their major fewer times, but took longer to graduate than non-STEM majors and that science majors took more hours a semester and had a higher average GPA than engineering and non-science students (Zhang, Thorndyke, et al., 2002).

Another concern is that STEM students leave their discipline for different reasons. A chilly climate and poor instruction are the most noted reasons for students leaving STEM (Haag & Collofello, 2008; Strenta, Elliott, Russell, Matier, & Scott, 1994; Tobias, 1990). In potentially the most revealing study of why students leave the sciences, Seymour and Hewitt (1997) revealed at least seven reasons for departure from science, math, and engineering (SME) many falling into the instruction and climate categories: (a) lack or loss of interest by student, (b) other non-SME majors more interesting, (c) poor SME teaching, (d) students overwhelmed by the rigor of the coursework, (e) lack of advising or counseling offered by department or college, (f) inappropriate choice of major, and (g) lack of preparation in mathematics and science. Additionally, Seymour and Hewitt found a lack of role models for women and underrepresented minority students led to increased departure. Zhang & RiCharde (1998) found similar reasons for leaving including the students' inability to handle stress, a mismatch between student expectations of the major and college realities, and a lack of commitment to the STEM major, which supported previous work by Waterman & Waterman (1972). With these similarities and differences accounted for and knowing a few of the reasons why students leave STEM, the primary differences in retention of STEM students can be better understood. The issues surrounding the concern for STEM retention centers on the inability to retain women, underrepresented minorities, and second tier students (Astin &

Astin, 1992) to the discipline, and the position of America's students in comparison to other countries.

America's competitiveness in the global market has been one of the major driving factors behind the push for science and mathematics literacy for all students and retention to graduation of more scientists and engineers. A few issues cause an increase to these concerns. In addition to the changing economic indicators showing exponential growth for Asian countries with only steady or no growth for the United States, the higher education setting is changing. Countries other than the U. S. are investing in their systems of higher education with significant resources going to the STEM disciplines (NSB, 2008c). These investments result in international talent and innovation staying abroad. Due to the different education systems and structures it is difficult to draw specific higher education comparisons between countries, but one indicator used often are tertiary degrees earned. These degrees would be the equivalent of a U. S. vocational or associate degree (NSB). According to the National Science Board, the number of tertiary degrees worldwide increased by 165% between the years 1980 and 2000. The U. S. share of these degrees dropped from 31 to 27% during the same period. Second, is the concern of where American students stand in comparison to other countries on national tests. Recent results from both the PISA and Trends in International Mathematics and Science Study (TIMSS) tests showed American elementary and secondary students being outperformed by other industrialized countries (NSB) in the areas of mathematics and science. As important, if not more, is the question of why American students do not choose to excel in mathematics. One study (Andreescu, Gallian, Kane & Mertz, 2008) based on the past 20 years of top-scorers from three top mathematic competitions proposed that the issue was based on socio-cultural and other environmental factors. The authors stated that what America does not have that other excelling countries do is a “rigorous mathematics curricula along with cultures and educational systems that value, encourage, and support students who excel in mathematics” (p. 1251). For U. S. born students, a social stigma, which appears to affect girls more than boys, has been attached to pursuing a talent in mathematics. Like reports discussed previously, the authors suggested that in addition to better identifying students with mathematical talent, the public perception must be changed to encourage all students to excel in mathematics, girls as well as boys (Andreescu et al.).

STEM Retention and Specific Populations

Retention of specific populations is an issue not unique to STEM, but one that has been an ever present problem with only minimal improvement. One area of concern is with what Tobias (1990) labeled “the second tier” student. The second tier was defined as that group of students who had some initial interest in science and some ability in the discipline, but were turned off with the college science curriculum. Tobias believed that the first tier would make it through the program no matter what, but that the second tier needed to be recruited, encouraged, and assisted to persist in science-related fields. Cultivating this group of students in addition to the cream of the crop will be necessary to fill the STEM positions of the future.

Women and underrepresented minorities are other populations where the largest portion of college level research in the STEM disciplines has been conducted over the last 20 years. This stems from many different facts. First, though over half of the nation's population is made up of women, only 36% of the graduates within the STEM disciplines are women. Even fewer of these women move on to graduate school and the science and engineering workforce (NSTC, 2000). Research has consistently shown that the reason women leave STEM is not based on their lack of academic ability (Adelman, 1998; Seymour & Hewitt, 1997; Tobias, 1990; Vogt, Hocevar, & Hagedorn, 2007; Zhang, Padilla, Anderson, & Ohland, n.d.; Zhao, Carini, & Kuh, 2005). Zhang et al. (n.d.) reported that women who began their study in engineering and chose to leave, typically left with higher GPAs, were more likely to graduate if they had a lower GPA, and migrated to math and science at a higher rate than men. Adelman (1998) and Seymour and Hewitt (1997) found that the STEM culture negatively influenced the persistence of women, confirming findings from previous studies. Socio-cultural, climate, and other environmental factors continue to be determined as a cause for STEM departure by women (Andreescu et al., 2008; Cole & Espinoza, 2008; Huang, Taddese, & Walter, 2000). Though women have the academic ability and are as engaged in the formal environments of STEM as their male counterparts, they participate less in informal interactions with peers and faculty outside the classroom (Zhao et al., 2005) creating disadvantages. Women in STEM disciplines have also been found to suffer from low self-efficacy (Vogt et al., 2007) and often underestimate themselves (Zhao et al., 2005). Though the gender gap has been shrinking, much work is left to be done.

Second, the science and engineering graduates and workforce of the past were made up of primarily white males. The STEM interest as well as the population total of this group has been steadily decreasing. Based on population growth, the workforce of the future is expected to see an increase in African American and a doubling of Hispanic and Asian workers (NSTC). Unless the pipeline leaks are fixed for these groups, there will not be enough trained workers with the skills for the science and engineering jobs of the future. For further evidence, in a study looking at the persistence of STEM students, Fenske et al. (2000) found that even though STEM majors persisted at a higher rate than any group at the institution, underrepresented minority (URM) STEM students had the highest departure rates. Offering no explanation as to why this occurred, the authors did recommend increased early interventions to provide academic and social support for these students. Though roughly the same percent of URM students intend to major in STEM, the actual number choosing these disciplines is lower, and the number graduating even lower. Research conducted for The Center on Education and Work (Byars-Winston, Estrada, & Howard, 2008) found that URM STEM interest was determined by whether the student perceived the effort was worth the reward and believed the ability was there to complete the program. Other findings included increased confidence in succeeding in the short-term, but not to graduation and a lack of belief in their ability to cope with complications. The authors recommended enhancing URM students' confidence and coping and academic abilities which would in turn positively influence other areas of college life. Yet another study recommended Latino student engagement in co-curricular activities including faculty-student involvement. Cole and Espinoza (2008) believed that high school preparation was the most important factor for URM STEM study. The findings of their research on Latino students and cultural capital, incongruence, and campus climate were consistent with previous research (Huang et al., 2000) in that Latina students were better prepared to study STEM disciplines, did better academically, and their departure seemed to be more socio-cultural. In addition to gender, time on task and faculty involvement also influenced GPA. Related to the concept of time on task, co-curricular activities were found to enhance the experience, but only if they were related to the discipline (Cole et al., 2008).

These past studies on improving the retention of critical STEM populations each provide similar recommendations. Easing the transition, building a sense of community, improving self-efficacy, creating a more nurturing culture with a less competitive and team-oriented environment, and providing academic and social support through informal opportunities using co-curricular as well as curricular activities resonate as themes for improving the persistence of students from the second tier, women, and underrepresented minorities in the STEM disciplines. Learning communities are one approach recommended to accomplish these tasks (Cole et al., 2008; Haag et al., 2008).

STEM Learning Communities

With the concept of learning communities already established, this review dealt specifically with the function of learning communities as related to the STEM disciplines. One way of grouping described in the learning community literature is student-type. The student-type grouping relevant to this investigation consisted of placing students in a cohort around a particular academic interest (Braxton & McClendon, 2002; Zeller, 2005). This type of learning community is important due to the negative effects of STEM disciplines on persistence in the major and timely graduation, especially engineering (Astin, 2006; Astin & Oseguera, 2005). Peer groups, a known positive influence on retention, are more likely to form around a common purpose (Astin, 1993; Pascarella & Terenzini, 2005). Students grouped with like-minded students are more likely to emulate the characteristics of that group and remain in the STEM disciplines (Astin & Astin, 1992; Pascarella, Terenzini, & Blimling, 1994). Additionally, student type learning communities allow students to get to know others in their major with whom they will have classes in the future, establishing a community earlier than the typical junior year when students enter the major (Lenning & Ebbers, 1999).

Due to the vast nature of the STEM educational community, there are a number of learning communities directed at populations other than undergraduate students. For example, programs like the Massachusetts STEM Initiative and the University of Texas Medical Branch, Texas STEM (T-STEM), focus on connecting colleges and local secondary schools for the advancement of STEM. Others like the Wisconsin Center for

Education Research focus on connecting faculty with STEM graduate students who aspire to be university professors. Still others like the Western Michigan Faculty Learning Community and the Center for the Integration of Teaching and Learning focus on faculty development. Though important to the health of the STEM initiative, these learning communities were not the focus of this investigation. However, because the focus of the STEM community is on the greater initiative, information on college level STEM student initiatives are less likely to be reported. Though these practices exist, descriptive reporting in peer reviewed journals is less than would be expected and assessment information is even worse. The most abundant information tends to come from conference proceedings. In a Google search of STEM living-learning communities over 500 results were returned on programs at various institutions. The majority of these postings were for recruitment to the programs not details of how the programs work. Currently, the most reliable learning community information can be obtained from two trusted resources: the Washington Center (2008) and the Educational Policy Institute (EPI). The EPI website houses a database that lists effective student success practices for higher education. Institutions register their programs and then the EPI runs an extensive review process to determine whether or not the program is a true best practice. Programs are ranked limited, promising, or effective based on the review. Of those listed in the database, only two of the ninety-nine programs met the criteria of a living-learning community. Both were minority programs and one was in the life sciences. The majority of programs for STEM disciplines fell under the categories of classroom instruction, mentoring, and tutoring with no mention of a specific learning community cohort. Within the Washington Center database, there were 295 regular learning communities. At least 99 of these were registered as residential programs, but only a small number were categorized as STEM specific. The database provides information on how programs were to be assessed, but no results. Unfortunately, because information was provided by the individual institution, not every record is complete.

Limitations in the Literature

Two drawbacks to collecting information on STEM learning communities seemed to exist. First, by whatever means information was reported, journal, database, conference proceedings, or other, assessment results were limited. Though not true for all interventions, this was especially true for the co-curricular components of the living-learning communities. Integrated curriculum was the most popular STEM intervention. Though a cohort or learning community was not always mentioned by name, a classroom or linked courses learning community was assumed in most instances and the assessment results for increased retention were almost always positive. A second limiting aspect was that the majority of information on college level intervention within the STEM disciplines tended to lean towards the field of engineering rather than incorporating all disciplines. One example, within the Journal of STEM Education, articles geared to the postsecondary level were primarily engineering. Science and mathematics journals were based on research, secondary education, teacher or faculty learning communities, classroom pedagogies, integrated courses, and concerns with student learning. Most leaned toward the topic of curriculum when, and if, the postsecondary level was addressed. The national agenda for science and mathematics literacy seems to have influenced the focus of undergraduate STEM study for these disciplines on improvement for all not on retention within the disciplines. This does not mean that discipline specific retention research does not exist in science and mathematics, but it seems to not be abundant. Though engineering has concerns based in science and mathematics preparation, engineering is a college level program, not secondary, so one would assume there would be more research into the discipline specific retention of this group of students. With this limitation acknowledged, the first year of study for STEM students, that is the preparation needed, the courses to be taken, and the experiences engaged in, are similar. In fact, many first-year interventions group these disciplines together (ACT, 2006; Cole et al., 2008; Daempfle, 2004; Gilmer, 2007; Hyde & Gess-Newsome, 1999; Muller & Pavone, 1997; Narum, 2008). Due to these likenesses, first-year interventions performed on one group can be inferred to produce similar results for all STEM students. A discussion of previously conducted research specific to STEM learning communities is necessary for framing the current investigation.

Associated Strategies

Those retention initiatives receiving the most attention in the STEM literature tend to be instructional pedagogies, learning communities which include mentoring, tutoring, and research only, and learning communities centered around course clusters or integrated curriculum which may or may not contain other elements. Curricular reform in

STEM is not that different than in other disciplines. Pedagogies reinforcing active, collaborative, cooperative, and group learning have been and continue to be encouraged (Bernold, 2005; Lord, 2008; Narum, 2008). These changes are critical to engaging students, breaking down the competitive environment, and motivating students in the study of STEM (Lord, 2008). Learning communities often provide environments for this type of curricular change.

Mentoring and research. Peer and faculty mentors provide social capital that first-year students do not possess, but need to successfully navigate the STEM community. Social capital refers to "the norms and values people hold that result in, and are the result of, collective and socially negotiated ties and relationships" (Edwards, 2002). The upper class students, faculty, and professionals provide guidance for students to overcome barriers to becoming members of the community. One learning community formed of women in science, math, and engineering consisted of student internships, peer and industry mentoring, and a twice-monthly newsletter (Muller & Pavone, 1997). Though the number of women declaring majors in science and engineering doubled from 1990 to 1997 and there was an increase in the percentage of women graduating in science and enrolled as seniors in engineering, the results did not show which areas of the learning community most contributed to the students' success. A study by Packard (2004) investigated faculty mentoring of science students. The researcher found that career mentoring was more significant for science pursuers regardless of gender and that there was no difference in psychosocial mentoring between pursuers and switchers. The psychosocial mentoring consisted of counseling, role modeling, and friendships. In another program that dealt purely with peer mentors, students chose a two–semester course sequence in either molecular biology, organism biology, or ecology where they conducted research individually or in a small group under a peer review process (Kight, Gaynor, & Adams, 2006). The first semester consisted of writing a peer-reviewed grant proposal and the second semester students conducted the actual research. More than 80% of the graduates were in graduate school or a research career four years after the program which was significantly better than the traditional 40 to 50% placement for other biology majors at the institution.

Academic support services. Providing academic support for students in their discipline has always been a key retention strategy, especially in the areas of science and mathematics. Tutoring is one activity that has been found to be effective, whether as a standalone program or as part of a learning community. The Counselor-Tutorial (CT) program was implemented at Purdue University in 1971 to provide supplemental instruction, counseling, and tutorial experiences to engineering students whose academic characteristics suggested they would have some difficulty with the engineering curriculum (Budny, LeBold, & Bjedov, 1998). Though showing some success, an overhaul of the program in 1990 added more intensive tutorial services. The new program soon boasted retention rates to 54%, a 20% increase over the old version of the CT program. In a survey of institutions participating in the American Society for Engineering Education, Brannan and Wankat (2005) reported that approximately 90% of the participating institutions offered some type of bridge or retention program to undergraduate students. The initiative topping the list was tutoring.

Curricular learning communities. One area of great focus for STEM studies has been clustered courses or integrated curriculum. In fact, a majority of the learning communities found in a search of the STEM literature include a curricular component. Due to this finding, a quick review of what the research on STEM curricular learning communities has uncovered was provided. This was followed by information on STEM learning communities which incorporate additional services and led up to what is known about STEM living-learning communities.

The overarching findings in the curricular learning communities literature were increased retention, academic performance, and peer and faculty interactions, along with development of a sense of community and friendships. Though these learning communities may have incorporated elements other than the courses, none were reported to do so. FIGs and team-taught were the common type of curricular learning communities used. A FIG at the University of Hartford developed for pre-medical, chemistry-biology, and biology majors connected a general chemistry, biology, and a pre-calculus course (Pence, Workman, & Haruta, 2005). In a comparison of participants and non-participants, the FIG participants showed an increased sense of community accomplished through increased faculty and peer interaction. Retention was found to have increased for the total group and more importantly for minority participants. Unfortunately, the assessment was weak using only descriptive statistics with no significance measures. Another FIG at the

University of Wisconsin – Madison (Courter & Johnson, 2007) was developed for engineering students and combined a freshman composition, engineering design, and calculus course. A lead faculty coordinated the material between the three classes which used pedagogies including active learning, peer review, and group experiences. Two cohorts, one in Fall 2005 and the other in Fall 2006, participated in similar experiences with slight differentiations in theme and pedagogical strategies. Based on student focus group results, relationship building was the best part of the FIG. The program was also able to show increased retention to the second year, help ease the transition to college, and assist students in making decisions about their career choice.

Team taught, more commonly referred to as integrated curriculum in the STEM community, is the most common type of curricular learning community. Increased retention, academic performance, and a greater sense of community continued to be the most common findings. A variety of integration methods were used. The University of New England (Morgan, Carter, Lemons, Grumbling, & Saboski, 1995) established learning communities for all of their "first-year life science and environmental science" students (p. 102). The community consisted of four courses which were taught using four modules over a year long period. A seminar at the end of each module was used to integrate what had been learned. Pre- and post-tests showed significant improvement in student intellectual development, but not until the third year of the learning community. The researchers believed this was because during the third year class size was reduced and a greater sense of community was able to be established among the students and faculty. Another addition during that period was the Introduction to Learning Community course which allowed for students to meet regularly to discuss the learning community and provide input on how things were done (Morgan et al.). During the early 1990s, NSF funded an Engineering Education Coalitions program with the goal to increase retention (Fentiman, Demel, Freuler, Gustafson, Merrill, 2001). The TIDE program at the University of Alabama (UA) was developed as part of the Foundation Coalition and incorporated technology and work teams into the clustered courses of chemistry, mathematics, physics, and engineering (Richardson & Dantzler, 2002). TIDE, the UA freshman-engineering curriculum, integrated topics between the courses and developed four person teams that moved between the courses working together in each. The TIDE program, now required by a number of engineering departments at UA, resulted in increased graduation rates with exceptionally higher rates for white females. No significant differences in GPA were found and non-white students had poorer, but not significant, graduation rates. The researchers believed that the "dominant effect" (p. S2C-21) of the learning community and the cause of the differentiation in graduation rates was due to the increased sense of community among the group members. Another Foundation Coalition partner, The Dwight Look College of Engineering at Texas A&M University (TAMU), used the same approach as UA's TIDE program (Morgan & Kenimer, 2002). First tested in 1994, by 1998 all engineering freshmen were participating in the learning communities. Findings for the TAMU program included increased retention, favorable student attitudes towards teaming, evidence of friendships through faculty observations, and voluntary clustering in following years. Morgan and Kenimer's study provided mixed results between the Foundation Coalition partners. Differences between the TAMU and UA programs included the increased retention rates of underrepresented minority groups participating in the learning community at TAMU with smaller increases in retention of white females, the opposite of the UA findings. One of the most complete integrated course models was developed by Drexel University (Fromm, 2003). "An Enhanced Educational Experience for Engineering Students" (p. 114), known as E^4, consisted of a total restructuring of the first- and second-year curriculum for engineering students. Mathematics, science, engineering, and humanities faculty worked together to create an approach that placed engineering at the center of the curriculum from the students first day of study. Two year retention rates were 21% above those of students in the control groups. Additionally, E^4 participants were "on track" (p. 115) in their major at a substantially more significant rate than the control group. The learning community under investigation included linked courses with an integration of science, engineering, and mathematics topics. Knowing the courses contribute at some level to retention and sense of community was an important variable to consider in the investigation.

Incorporating Multiple Strategies in Learning Communities

The social integration of students is most important during the first-year, especially the first semester, so focusing on what occurs outside the classroom is as important as the curricular changes that have taken place (Astin, 1985; Boyer, 1987; Levitz & Noel, 1989; Smith et al., 2004). Froyd and Ohland (2005) conducted a comprehensive analysis of integrated engineering curricula and the connection to learning communities. The researchers acknowledged that the integrated courses were standalone learning communities, but could be incorporated into the "larger context of learning communities" (p. 147) to further develop academic and social ties to the engineering community. Their analysis identified nine themes for outcomes across forty-one integrated programs. Those important to supporting this investigation were improving learning and retention, addressing the needs of underrepresented groups, and developing social and academic connections. Though a few of the programs used the courses as a part of a larger learning community effort, Froyd and Ohland focused only on the integrated curricula. For those learning communities focusing on more than the integrated curriculum, similar outcomes have been found. Clark, Revuelto, Kraft, and Beatty (2003) conducted an analysis of the five Foundation Coalition learning community programs focusing on the cohort, not the curriculum, established at each institution. Though the programs varied, each consisted of a cohort in two or more linked courses and utilized undergraduate and graduate students as tutors, mentors, or teaching assistants. The qualitative study identified five learning benefits that were influenced by the learning community cohort: (a) learning to work in teams, (b) identifying their own learning style, (c) learning best how to get assistance, a strategy that always started with asking the student's peers first, (d) learning to survive college and how it is more difficult than expected, and (e) learning to think like engineers. Another such effort that expanded from integrated curriculum found success in increasing graduation rates, the ultimate goal of retention. Developed at the Colorado School of Mines (CSM), *Connections* (Olds & Miller, 2004) integrated the engineering first-year curriculum and provided a supportive learning community. Their goal was to foster a setting that would

> "achieve the four outcomes Tinto [1] associates with successful learning communities: formation of self-supporting groups; more active involvement in classroom learning than other students; enhance quality of student learning; and higher persistence rates than comparative students in the traditional curriculum" (p. 23).

The *Connections* learning community grew out of a student desire for more social interaction in addition to the academic integration. The longitudinal study reported that the second year cohort, when the learning community was implemented, resulted in an 84% graduation rate within five years, a better rate than the previous year without the formal learning community (Olds & Miller). The CSM learning community showed that social added some strength to the integrated curriculum in terms of retention to graduation. As discussed previously, peer or faculty mentoring, influential standalone efforts, were included in successful STEM learning communities (Della-Piana, Arenaz, Fisher, & Flores, 2001; Fisler, Young, & Hein, 2000; Gilmer, 2007; Pahwa, Soldan, Starrett, & Maier, 2007; Pogranichniy, Burras, & Polito, 2001). Other STEM learning communities incorporated the use of co-curricular activities including field trips, social activities, academic student organization meetings, tutoring, and study groups (Gilmer, 2007; Ohland & Collins, 2002; Place, Aller, & Tsang, 2006; Pogranichniy, et al., 2001). Place et al. (2006) found that co-curricular activities incorporated as part of Western Michigan University's learning community aided in the development of first-year engineering and technology students. In one instance, group study was important to students not only for the assistance that was provided, but also for the location that was allocated for the activity (Gilmer, 2007). The students felt that the space dedicated for the learning community provided a “sense of belonging” (p. 17) for the participants.

STEM Living-Learning Communities

Despite the inclusion of other co-curricular activities as key aspects in STEM learning communities, very few reported providing a residential component. For those that did boast living-learning communities, assessment on the residence portion was minimal or non-existent. Because the investigation at hand centered on a STEM living-learning community (LLC), previous research was critical for a complete understanding. Early support for the use of residence halls for STEM retention came from Jaleh Daie (1994), former president of the Association for Women in Science. Daie believed five elements were critical to the success of a residential learning community:

(a) shared interest in related disciplines such as science, math, and engineering;

(b) provision for regularly scheduled seminars, lectures, and discussion groups;

(c) availability on a regular basis, of intellectual resources such as faculty and graduate students to serve as mentors and tutors;

(d) presence of important resources such as an on-site computer facility, library, reading and study rooms, in internships or research experience on or off campus;

(e) provisions for social activities underpinned by the common academic interest (field trips, lab visits, campus events, and organizations). (p. 160)

Daie's opinions were based on observations of increased numbers of women declaring science majors at Rutgers University's Douglass College which began a residential learning community in 1986. Assessment findings, when available, have been fairly consistent on the effectiveness of LLCs in retaining STEM students. In a study of women in science and engineering (WISE), Gandhi (2000) found that there were no significant differences in retention to the university or academic performance between women in the LLC and those in the traditional residence hall. The only significant finding, an important one to this investigation, was that the LLC participants had increased retention to the science and engineering majors. Hathaway, Sharp, & Davis (2001) in looking at another WISE residential program found support for the program in retaining science women, but not those in engineering. The authors advocated the need to combine academic and social support in LLC programs. In 2002 Ohland and Collins began a meta-analysis of engineering learning communities by cataloging the programs. Unfortunately, due to the lack of published assessment identification of best practices was not possible. Relevant to this investigation, of the 25 learning communities identified, 23 contained a residential component. However, only a handful of those had published assessment referring to the residence hall. In most, no specific testing of the residence hall influence was conducted. For example, Beckett & Marrero (2005) compared a residential FIG at the University of Missouri-Columbia to non-FIG participants. The FIG students were more likely to be retained and discipline specific graduation rates of engineering students in the FIG increased. As in Gandhi's (2000) study, academic performance differences between the participants and non-participants were minimal and not significant. Data specific to the different components of the FIG, including residence, were not addressed. Similarly in the Agricultural and Biosystems Engineering learning community (ABE LC) at Iowa State University, the program was assessed as a whole (Mickelson & Brumm, 2005). Results were positive showing increased retention and sense of community of ABE LC participants, but no differentiation was made between the ABE LC and ABE LLC students. The authors admitted the data collected for the program was overwhelming and future studies would be conducted once everything could be evaluated. Other LLC programs, those identified by Ohland and Collins (2002) and others evolving since that time (Davis, 2008; Kahveci et al., 2006; Kampe et al., 2007; Thompson, Oakes, Bodner, 2005; Tsang, Halderson, & Kallen, 2007), continued to find positive effects on STEM first-year retention and sense of community, but did not assess which activities within the LLC were providing the most influence. Kampe et al. (2007) provided some beneficial information in that the students reported living with other engineering students was an important piece of the freshman LLC. Two more recent studies provided insight into the influence of other aspects in LLC. Using data from the National Study of Living Learning Programs (NSLLP), Johnson, Soldner, and Inkelas (2006) compared residents who participated in an LLC to residents who did not participate in the LLC. LLC participants found their residence environment to be more supportive, both academically and socially. Specific to STEM women residents, the researchers looked at those participating in a (a) non-science LLC, (b) women in science and engineering (WISE) only LLC, and (c) co-ed STEM LLC. Results indicated that women participating in the co-ed STEM LLC received the greatest benefits. Another study conducted by Hildreth and Brown (2007) looked at social networks in an engineering LLC. Like Johnson et al. (2006), though a much smaller population, a comparison between LLC participants and non-participants who lived on-campus was made. Using the social networks established by students to measure social capital the authors suggested that “with whom students interact and the degree of interaction with other engineering students may have a positive influence on retention of engineering students” (¶ 1). The LLC and non-LLC participants spent the greatest amount of time with students they lived with. For LLC participants this meant time with students in their major. For the non-LLC participants time was spent with other majors. Results indicated that the LLC participants were more likely than the non-LLC participants to persist in engineering at the end of the first year reinforcing the importance on retention of social connections to the STEM community.

With a more thorough understanding of the issues behind the retention of STEM students and knowledge of what efforts have been implemented toward this goal, this investigation was armed to press deeper into the influences on STEM retention. Throughout the review of literature on learning communities and specifically within the STEM community, areas of importance to retention were identified. As research showed, a lack of community presented a negative impact on students (Astin, 1993). Students must identify with and make social connections to the institution or smaller communities within the institution to survive the first year or, in the case of STEM research, to survive within the discipline during the first year. Learning communities are one strategy proven to provide an opportunity for connection. Establishing a sense of community is key due to the potential affect on retention within a course, discipline, or institution. This investigation looked to determine the perception of participants' sense of community within the LLC and evaluate the relationship of the learning community components on the LLC participants' sense of community. Before doing so, a thorough understanding of sense of community was necessary.

Sense of Community

The study of psychological sense of community (PSC), commonly referred to as sense of community (SOC), has been researched since the early 1920s. Community research has been conducted in the context of race relations (Byrne & Wond, 1962; Park, 1924), neighborhoods and metropolitan areas (Chavis, 1983; Dolittle & MacDonald, 1978; Riger & Lavrakas 1981), and team competition (Myers, 1962; Peterson & Martens, 1972). A review of the literature by Lounsbury and DeNeui (1996) included SOC research in the areas of crime prevention (Levine, 1986), community organizations (Chavis & Wandersman, 1990), properties of small groups (Compas, 1981), union participation (Catano, Pretty, Southwell, & Cole, 1993), and a couple of studies as SOC pertained to the university setting (McCarthy, Pretty, & Catano, 1990; Pretty 1990).

Elements of the Theory

As covered previously, for this investigation the importance of a presence of sense of community in the university setting was the potential affect on retention within a program or institution. McMillan and Chavis (1986) defined sense of community as, "a feeling that members have a belonging, a feeling that members matter to one another and to the group, and a shared faith that members' needs will be met through their commitment to be together" (p. 9). The definition consisted of four elements, membership, influence, integration and fulfillment of needs, and shared emotional connection. In 1996, McMillan extended the original definition and theory rearranging and renaming the basic elements. This extension provided a deeper spiritual connection to the theory rather than additional clarity. Both the original and renamed elements were discussed further.

McMillan and Chavis (1986) defined the first element, membership, as "a feeling of belonging" (p. 9). Within membership there were five attributes that assisted in determining who made up the membership of the community: boundaries, emotional safety, sense of belonging and identification, personal investment, and common symbols. Boundaries determined who was or was not included in the group. McMillan and Chavis were concerned that the true need for communities to set boundaries to protect the freedom of open sharing within the group was often overlooked. They spoke of common items or symbols, which included clothing, language, and ritual, used to identify boundaries. The boundaries helped to ensure the security, specifically the emotional safety, of the group. McMillan and Chavis used examples of gangs and collectives to represent other types of security, like physical and economic, provided to the community. Fitting into the group and feelings of belonging were critical elements in McMillan and

Chavis' idea of membership. As commitment to the group advanced, willingness to make sacrifices for the group and outward identification as a member became more common place. Personal investment by members strengthened the feelings of an earned position within the group and provided a greater sense of value or meaning due of the commitments made. The final attribute, common symbols, were used not only to define boundaries, but also to represent unity among the members. In the extension of this theory, McMillan (1996) replaced membership with the concept of spirit, grounded in the "spark of friendship" (p. 315). The attributes of boundaries, sense of belonging, and emotional safety remained in-tact, but were discussed in terms of truth and faith. To have SOC, individuals had to be willing to share the truth and the community had to be willing to accept and respond with the same willingness as the truth-teller. Members had to have faith they belonged and the community would respond with acceptance.

McMillan and Chavis' (1986) second element of SOC was influence. They believed that the community must have influence on the individual, but at the same time the individual must be able to apply some influence on the group in order to be interested in membership. Successful communities often exist where membership is seen to be mutually rewarding (McMillan & Chavis). Described as "bidirectional" (p. 11) influence this element was necessary to create group cohesion. The authors expressed some concern over "exert[ing] influence on its members to attain conformity" (p. 11), but upon review of the literature found there was "a positive relationship between group cohesiveness and pressure to conform” (p. 11). McMillan (1996) renamed this element trust believing that without trust by the member and the group no influence could occur.

Integration and fulfillment of needs, more commonly referred to as reinforcement, was the third element. Members’ needs must be met in order for continued cohesiveness and membership in the group. McMillan and Chavis (1986) believed status as a member and competence of other members were common “reinforcer(s)” (p. 13). The idea was that “a strong community is able to fit people together so that people meet others’ needs while they meet their own” (p. 13). Renamed trade (McMillan, 1996), the understanding was that communities typically came together based on similarities, but needed differences to establish a trade system to meet the needs of others in the community. Once trust was established, trading could go from sharing similarities to “criticisms, suggestions, and differences of opinion” (p. 321).

The final element of the SOC definition was shared emotional connection. According to McMillan and Chavis (1986), shared history plays a critical role in developing this connection. Members must identify with a “shared valent event” (p. 14) which increases the bond within the community. Frequent quality interactions, referred to by the authors as “contact hypothesis” and “quality of interaction” (p. 13), closure to events, personal investment, honor within the community, and forming a spiritual bond were other features contributing to a shared emotional connection. Two formulas were proposed to represent shared emotional connection:

Formula 1: Shared emotional connection = contact + high-quality interaction

> Formula 2: High-quality interaction = (events with successful closure – ambiguity) X (event valence x sharedness of the event) + (amount of honor given to members – amount of humiliation). (p. 15)

McMillan (1996) renamed this element art. Like the original theory, contact between members was necessary for SOC development while the quality of those contacts was crucial for continued facilitation, or inhibition, of group SOC. Art consisted of those events or experiences that were shared and dramatic in the life of the group. Dramatic experiences were risk-taking events that represented the values and traditions of the group (McMillan).

Both the original SOC theory and McMillan's extension viewed the elements as being "linked in a self-reinforcing circle" (p. 323) each influencing and being influenced by the other. Unable to adequately describe this influence, McMillan and Chavis (1986) provided an example set in the university environment for easier comprehension:

> Someone puts an announcement on the dormitory bulletin boards about the formation of an intramural dormitory basketball team. People attend the organizational meeting as strangers out of their individual needs (integration and fulfillment of needs). The team is bound by place of residence (membership boundaries are set) and spends time together in practice (the contact hypothesis). They play a game and win (successful shared valent event). While playing, members exert energy on behalf of the team (personal investment in the group). As the team continues to win, team members become recognized and congratulated (gaining honor and status for being members). Someone suggests that they all buy matching shirts and shoes (common symbols) and they do so (influence). (p. 16)

Other observations made by McMillan and Chavis included the idea that SOC was not a static concept. Over time and through the influence of individual and external factors a member's or community's SOC can change. Additionally, the authors observed that individuals can be members of many different communities. Ultimately it is the individual that must determine which community takes priority over the others. This “top allegiance” (p. 19) is determined by the individual’s values and critical needs at a specific point in time.

Students are influenced by many factors both internal and external to the institution and can easily claim membership in multiple communities. Investigating a students’ SOC in a specific sub-community within the institution may provide valuable information to administrators. This knowledge can assist in the identification of factors that reinforce or inhibit behaviors (McMillan & Chavis, 1986) and the design of program initiatives leading to increased SOC and potentially greater student retention in the university.

The University Connection

Researchers have shown the usefulness of developing SOC as a factor in the study of university settings (Lounsbury & DeNeui, 1995). Due to this, the investigation of SOC in a campus environment has become more popular in the last decade (Best, 2006; Buck, 2006; Cheng, 2004a, 2004b; Devlin, Donovan, Nicolov, Nold, & Zandan, 2008; Harris, 2007; Jacobs & Archie, 2008; Wright, 2004). Even with more empirical evidence available, it is important to understand why the connection between SOC and the study of communities on campus, in this case learning communities, is a good fit. For this, some understanding of community philosophy specific to university life and campus are necessary. This review showed the link between Boyer’s (Carnegie Foundation for the

Advancement of Teaching, 1990) principles of campus community, Schroeder's (1994) essential principles of learning communities, and McMillan and Chavis' (1986) SOC elements (see Table 5).

Principles of Campus Community

In *College: The Undergraduate Experience in America*, Boyer (1987) found that two out of five students did not feel a sense of community on campus. He reported that a separation between the academic and social experiences of students had been occurring for decades and that faculty and students must come together, both in- and out-of-class, to build a community of learners. He even encouraged creating educational programs in residence halls, supporting the living-learning community concept, to promote a sense of community on campus. A short time later, Boyer (Carnegie Foundation, 1990), in the prologue of *Campus Life: In Search of Community*, voiced his concern for developing community within society as a whole when not even those within the university could come together on a common vision. Though community within the university was not a new topic in the 1990s, there were factors at work requiring leaders to take another look: diversity of the student population as never seen before, the fragmentation and compartmentalization of the institution, and an undefined governance structure from *in loco parentis* to accountability (Carnegie Foundation). Boyer questioned whether a sense of community could even be established under these conditions. The report that followed offered six principles that "define the kind of community every college and university should strive to be" (p. 7). According to Boyer, a community should be purposeful, open, just, disciplined, caring, and celebrative. A look at each individual quality and its relationship to sense of community theory (McMillan & Chavis, 1986) follows.

Table 5.

Comparison of McMillan and Chavis' Sense of Community Theory, Boyer's Principles of Campus Community, and Schroeder's Principles of Learning Communities

McMillan & Chavis	Boyer	Schroeder
Membership	Purposeful, open, just, caring, celebrative	Involvement
Influence	Purposeful, open, just, disciplined	Influence
Integration & fulfillment of needs	Purposeful, open, just, caring	Investment
Shared emotional connection	Disciplined, caring, celebrative	Identity

Note. Elements of theory and principles retrieved from McMillan and Chavis (1986), Carnegie Foundation (1990), and Schroeder (1994).

The first principle of campus community is that all institutions should strive to be "educationally purposeful" (Carnegie, Foundation, 1990, p. 7). The mission of the institution was to be clearly focused on learning with faculty, staff, and student alike committing to this mission. One focus of the report was the critical role faculty play. Often times faculty rewards are not structured to support good teaching habits and time spent with students. Because the classroom is where learning begins, faculty should be encouraged to implement active and cooperative learning techniques to advance students toward greater learning. The principle of purposeful community relates in several ways to McMillan and Chavis' (1986) SOC theory. A purposeful community requires that commitment to the mission exists and that all members of the university community be responsible for its implementation (Carnegie Foundation). Commitment and responsibility to the mission create boundaries for membership and show personal investment (McMillan & Chavis) in the community. The mission also serves as a common symbol for the members. Conformity to or acceptance of the mission implies some influence by the institution on the university members while members taking action, or not taking action, to support the mission shows the influence members can have on the institution. Finally, shared values implied by the common mission, help establish the fulfillment of needs for the group and each individual (McMillan & Chavis).

The second and third principles of community that each campus should strive to meet are being “open” and “just” (Carnegie Foundation, 1990, p. 7). Open communities were defined as places where freedom of expression was protected and civility expected. People listened carefully to what others had to say and spoke thoughtfully. Communication was not used as a weapon, but as a tool to better understand one another (Carnegie Foundation). Just communities were “places where sacredness of the person is honored and where diversity is aggressively pursued” (p. 7). These principles are reflected in many of the elements of SOC theory. To develop a sense of belonging, a critical component of McMillan and Chavis’ (1986) membership, members of the community must be open to communication of new ideas. A person’s fit in the group will be determined by his or her ability to communicate with and understand other members. Additionally, when being truthful in open communication one personally invests (McMillan & Chavis) in the group. Through this open communication trust develops and influence follows. Members begin to share an emotional connection (McMillan & Chavis) due to the quality interactions that take place. These quality interactions are viewed as rewarding and begin to fulfill needs of group members. Likewise, the just community that pursues diversity is necessary for fulfillment of needs. Without differences, community members would all be alike and would not be able to meet the needs of one another through those differences. McMillan's (1996) element of trade is dependent on diversity in the membership.

The Carnegie Foundation report identified the fourth principle of a campus community as one that is "disciplined" (Carnegie Foundation, 1990, p. 7). In a disciplined community members accept their responsibilities, abide by the rules, and honor the values set forth by the community. Boyer's disciplined community directly relates to two elements of SOC theory as defined by McMillan and Chavis (1986). First, as part of a shared emotional connection (McMillan & Chavis), members receive rewards or suffer humiliations based on their commitment to the group. This commitment is shown by members' willingness to do as the group says – to follow the rules. McMillan (1996) called this paying dues. He stated, "If the required sacrifice is too great, it can weather the member's attachment to the community" (p. 318). The member may then be unwilling to accept the responsibilities and follow the rules of the community. Second, and more direct, for McMillan and Chavis' element of influence to occur, authority and rules must exist. This was brought out in McMillan's (1996) discussion on what he called trust. He believed that influence, or trust, was based on the power of the group. This power was determined by the order established and the existing authority within the group. A disciplined community sat center stage in McMillan and Chavis' SOC theory.

To Boyer, the fifth principle was what held the other principles together. A "caring" (Carnegie Foundation, 1990, p. 8) community was one "where the well-being of each member is sensitively supported and where service to others is encouraged" (p. 8). Members of the community, in this case students, want to feel that faculty and staff are concerned about them as individuals (Carnegie Foundation). As is also evident through retention theory (Tinto, 1993), social integration is a necessary component of community building. Through the Carnegie Foundation report Boyer showed support for connecting to students through mechanisms like living-learning communities, knowing that creating community in sub-communities may be necessary before students can realize community at the institutional level (Carnegie Foundation). The principle of caring directly ties into SOC theory. SOC is established by an individual's need to belong which is made up of two features: (a) frequent contact and (b) caring (Baumeister & Leary, 1995). Shared emotional connections require frequent quality interactions and personal investment. These quality interactions occur only when caring or concern is present within the group. Emotional intimacy, a form of personal investment (McMillan & Chavis, 1986), is more likely to occur in a caring community. Caring also leads to integration and fulfillment of needs for members. Feelings of being cared for can be viewed as a reward for membership. Both McMillan (1996) and Boyer referred to the spirit of the community. This spirit of the community would be determined by the quality of connections between the members.

The final principle of campus community is the idea of a "celebrative" (Carnegie Foundation, 1990, p. 8) community where the history of the institution is honored and rituals affirm "tradition and change" (p. 8). Because SOC is not a static concept, it must be sustained over time. To accomplish this, institutions recreate SOC through rituals and tradition (Carnegie Foundation). Sense of community theory identifies with celebrative communities on two elements. First, membership is defined by boundaries and symbols (McMillan & Chavis, 1986). Participation in rituals and traditions of an institution define the boundaries and represent the symbols of that community. Second, a shared emotional connection, or art (McMillan, 1996), comes about through shared meaningful events. These events represent the values and traditions of the group.

Like McMillan and Chavis (1986), Boyer understood that increased sense of community could create isolation of sub-communities. To avoid this polarization, Boyer felt sub-communities were not enough and that a connection to the larger campus community must also be established (Carnegie Foundation, 1990). Boyer's principles were to be used as guides to build community on campus. Similarly, McMillan and Chavis saw SOC as a way to provide "a base on which we can facilitate free, open, and accepting communities" (1986, p. 20). Both McMillan and Chavis and Boyer saw community as the way to promote common good in a world about which many have dreamed. An obvious connection between the two concepts of community exists.

Principles of Learning Communities

Originally proposed in 1993, Schroeder's (1994) principles for learning communities are more obvious in their connection to McMillan and Chavis' (1986) theory in that they encompass the theoretical construct of SOC. The "four essential principles" (Schroeder, 1994, p. 174) were labeled as involvement, investment, influence, and identity. The learning community principles were so closely related that they shared much of the same language and labels.

Similar to McMillan and Chavis, Schroeder (1994) believed that membership defined the community and a successful learning community required involvement by students. Current members, or returning students, took responsibility for educating new members in the traditions and rules of the community (Schroeder). Involvement by the members allowed them to not only take responsibility, but to make personal investments in the group. The more involved, the higher the degree of the investment.

Schroeder's second principle of learning communities, investment, represented ownership of the group. He also believed that the investment by students was "a consequence of the ethic of care" (p. 175) that occurred between members of the group. The investment by students increased their integration into the group and their fulfillment of needs (McMillan & Chavis, 1986). The status of being a member of the learning community could be interpreted as reinforcement and good members were rewarded for their contributions (Schroeder, 1994).

Influence, Schroeder's third principle of learning communities, mirrored the concept of McMillan and Chavis. As a result of the involvement and investment, students in a learning community heavily influenced their environment or group. In turn, the group exerted influence on the members by determining and enforcing rules and codes of conduct by which members should abide (Schroeder, 1994).

The last learning community principle related to the shared emotional connection in the SOC theory. Identity with the learning community was formed through shared values and historical events and was represented by the common symbols and rituals of the group (Schroeder, 1994). Frequent high quality interactions within the learning community allowed students to develop relationships and begin identifying themselves to the external community as a united group. Schroeder wrote of symbols like wearing jerseys and referring to the learning community members as "*we* and *us*" (p. 176).

Schroeder (1994) stated that though purpose and elements of learning communities can vary, these four principles must remain constant. Like the elements in sense of community theory (McMillan, 1996; McMillan & Chavis, 1986), Schroeder believed that the four principles of learning communities were "sequential and cyclical" (Schroeder, 1994, p. 175). In what McMillan (1996) called a "self-reinforcing circle" (p. 323), the SOC elements and the learning community principles affect and are affected by each other. Schroeder describes this relationship best: "Increased student involvement leads to increased investment, which, in turn, leads to greater influence and eventual identity with the unit. The greater the identity, the greater the involvement, investment, and influence" (p. 175).

In addition to McMillan and Chavis' (1986) elements of SOC receiving support from the popular retention theory (Astin, 1985; Braxton, Hirschy, & McClendon, 2004; Tinto, 1993), these same elements are backed by discussions of community within the university setting (Carnegie Foundation, 1990; Schroeder, 1994). These findings suggest SOC as a good construct to use in the further examination of the use of learning communities to accomplish community within the institution as it links to student retention.

The Research

Early psychological sense of community (SOC) research was conducted in areas other than the university setting (Byrne & Wond, 1962; Catano, Pretty, Southwell, & Cole, 1993; Chavis, 1983; Chavis & Wandersman, 1990; Compas, 1981; Dolittle & MacDonald, 1978; Levine, 1986; Myers, 1962; Park, 1924; Peterson & Martens, 1972; Riger & Lavrakas, 1981). Community findings about groups like neighborhoods, unions, and the workplace informed future work in the university community. The bulk of university research has occurred since the late 1980s and early 1990s. Previous research included system or college-wide community (Bailey, Bauman, & Lata, 1998; Cicognani et al., 2008; Cheng, 2004a, 2004b; Lounsbury & DeNeui, 1995; McCarthy, Pretty, & Catano, 1990), college/university size (Lounsbury & DeNeui, 1996), college transitions (Tucker, 1999), personality types (Lounsbury, Loveland, & Gibson, 2003), and distance learning (Dawson, 2008; Rovai, 2002a). Research on communities within the university included classrooms (Ke, 2006), undergraduate academic departments (Sanders, Basham, & Ansburg, 2006), residence halls (Berger, 1997; Devlin et al., 2008; Pretty, 1990), first-year students (DeNeui, 2003; Jacobs & Archie, 2008) and other defined learning communities (Buck, 2006; Harris, 2007; Lingren, 2003; Wright, 2004). The concept of SOC was investigated further. A few recent SOC studies in non-university settings with findings relevant to this research were discussed followed by a review of relevant literature in the university setting.

External Environments Contributing to the University Setting

Davidson and Cotter (1991) studied the relationship of SOC to an individual's sense of well being. Based on feelings towards their city of residence, individuals completed the Sense of Community Scale (Davidson & Cotter, 1986) which encompasses McMillan and Chavis' (1986) elements of SOC. The most relevant findings were that SOC influenced an individual's happiness and interventions focusing on SOC could heighten the sense of well being. Another study by Davidson, Cotter, and Stovall (1991) used the same methodology in determining a positive relationship between SOC and the need for affiliation. Findings from the research supports the idea that part of an individual's (student) successful integration into the city (university) revolves around their sense of belonging, fit, and comfort with their environment and that appropriate interventions could assist in retaining individuals (students) in these environments. The need to affiliate with others supports the idea of using smaller sub-groups of students (learning communities) to increase SOC on campus.

In a study of adolescents ages 15 to 19, Pretty, Andrewes, and Collett (1994) used the Sense of Community Index [SCI] (Chavis, Hogge, McMillan, & Wandersman, 1986) to investigate a student's SOC and its relationship to loneliness in both school and neighborhood environments. Relevant to the current investigation, the researchers found that there was a significant relationship between school SOC and the number of supports and tangible assistance provided to students. Additionally, the school SOC was a strong predictor of loneliness felt by students. Though performed on a slightly younger population, the findings support the idea from the retention literature that students benefit when provided with tangible supports. Environments that nurture SOC should provide multiple support services to students. Living-learning communities are such environments. As SOC grows, students' feelings of loneliness should decline and integration into the community setting can occur.

Research looking at multiple senses of community provided findings important to the current investigation. Royal and Rossi (1996) compared SOC among participants and non-participants of nested sub-communities. The researchers found that there was a positive relationship between membership in a sub-community and a student's SOC for both the sub-community and the larger community. This finding helps support the idea of McMillan and Chavis (1986) and Boyer (Carnegie Foundation, 1990) that increased community in a smaller environment leads to increased community in the larger environment and perhaps, society in general. Brodsky and Marx (2001) furthered this type of investigation by looking at multiple senses of community for the same individual at a macro and sub-community level. Using participants in a job training program at a women's education center, Brodsky and Marx found multiple senses of community did exist and in fact the macro- and sub-communities were "mutually dependent" (p. 176) on one another. The researchers suggested that to balance the SOC of both environments the macro-community had to see the sub-community as non-threatening and as a "necessity and resource" (p. 176) for accomplishing the greater SOC of the center. Even within the smaller learning communities of a university, sub-communities of staff, students, and faculty exist. The learning community must acknowledge the SOC that may exist at these lower levels and realize its importance to the SOC of the learning community as a whole.

University Settings

Using sense of community as a construct to study institutions of higher education has become more popular in the last 20 years. Early research consisted of broad investigations of SOC in the university (Lounsbury & DeNeui, 1995, 1996; McCarthy, Pretty, & Catano, 1990). This research set the stage for the use of SOC in the university setting and the implementation of interventions for increasing SOC on campus. This review showed the connection of SOC to the study of retention, why SOC was a good construct for research on STEM students, the existence of the influence of proven retention strategies on SOC, and concluded with support for this investigation.

In an early study of SOC in the university, McCarthy et al., (1990) investigated the relationship between SOC and student burnout. Using the McMillan and Chavis (1986) model for community and two measures for burnout: the MBA (Meier and Schmeck, 1985) and revised MBI (Meier, 1983), the researchers surveyed 360 undergraduate students. By conducting correlation and regression analysis, McCarthy et al. found a significant negative relationship between SOC and burnout suggesting that interventions to decrease burnout, which may lead to departure, be directed not only at the individual, but also the college community in which the student resides. What the researchers were unable to determine was a causal relationship between burnout and SOC.

Other investigations supporting the use of SOC in the university setting have been conducted by Lounsbury and DeNeui (1995, 1996). In a study of SOC on campus, Lounsbury and DeNeui (1995) investigated the relation of SOC to a number of campus environment factors. Not convinced other SOC instruments were valid for use on campus, the researchers used their own instrument (Lounsbury & DeNeui, 1996) to survey over a 1,000 undergraduate students from 23 campuses across the U.S. What they found were significant relationships between student SOC and all of the environmental variables tested. Three environmental variables were of relevance to this investigation. First, students in certain majors had significantly lower SOC scores. Engineering and life science students were found to have low SOC while mathematics and other science students had higher SOC scores. The researchers suggested further study should be done on the relationship between SOC and student major. Second, higher SOC scores were found for members of fraternities supporting the idea of sub-communities within the larger university especially those where students are highly involved. The third finding of higher SOC scores for those students living on-campus than those who live off-campus supports the literature on retention. Many of these same findings were confirmed in a second study by Lounsbury and DeNeui (1996). However, the main focus of that research was to investigate SOC in relation to institutional size and student extroversion. Here the researchers found that students attending lower enrollment institutions had higher SOC scores than those at larger institutions. Interestingly, they also found that extroversion was significantly related to student SOC and accounted for more variance in SOC scores than did institution size. These findings raised the question on whether SOC was a function of personality or environment, ultimately setting the stage for later work on the relationship between SOC and personality (DeNeui, 2003; Lounsbury, Loveland, & Gibson, 2003).

Findings from early university SOC research that influenced this investigation, first, included the idea that interventions to increase student well being should be directed not only at the individual, but also the community in which the student resides. Second, a student’s major influences SOC and, more importantly, the disciplines included in this investigation were split between low SOC (engineering and life science) and significantly higher SOC (mathematics and other sciences). Third, further investigation is needed to determine if the same findings regarding fraternity and sorority sub-communities exist for other sub-communities in the university. Fourth, consistent with the retention literature, living on-campus provides benefits to students, in this case, with an increased SOC. Fifth, lower enrollment institutions had higher SOC scores than those at larger institutions furthering the idea of using smaller sub-communities to attempt to increase the SOC experienced by students. Lastly, extroversion was significantly related to student SOC identifying a potential need for certain groups of students to receive more interventions to increase SOC.

Connection to retention. The study of the relationship of SOC with retention and student success in the classroom has been the primary focus of only a few investigations (Harris, 2007; Jacobs & Archie, 2008; Ke, 2006; Tucker, 1999). Tucker (1999) suggested the use of vision and SOC instead of Tinto's (1993) social and academic integration in the investigation of retention. In his previous doctoral work, Tucker (1998) found that vision and sense of community were two factors which eased student transition into the university. Those students with the clearest vision of what they would do after graduation were those that experienced the easiest transition. Additionally, those with the greatest sense of belonging, established through sense of community, would show an increase in their ease of transition. Supported by the findings from his qualitative study, Tucker (1999) believed that sense of community was the better construct because it took into consideration all things that impact a student's belonging rather than trying to separate them, like Tinto, into two distinct areas, social and academic. Finding that students must feel a part of the community in order to do their best, Tucker recommended designing programs to aid in the facilitation of SOC implying this would facilitate retention at the institution.

Investigating the relationship between SOC and the success of students in a classroom environment, Ke (2006) conducted a causal-comparative study between business and engineering students in a face-to-face and online course. He determined there was no significant difference in the level of sense of community, determined by the Classroom Community Scale (Rovai, 2002b), in either setting based on learning style, gender, and peer-acquaintance level. However, he did find a positive correlation (.49) between SOC and course grade. Ke's study lends support to the idea that increased SOC could positively influence the course grades of STEM students. Following suit with Ke's research, Buck (2006) examined classroom and university SOC in learning community (LC) participants. Specifically, Buck wanted to know if students participating in a LC had a greater SOC in the classroom and the university than their non-LC counterparts. The LC was based on participation in a series of seminar courses at the institution. Not surprisingly, she found that LC participants had a higher SOC than non-participants. Though participation in an LC did not guarantee increased university SOC, those with higher levels of classroom SOC did have a stronger university SOC. Buck was able to show a link between the LC and greater social and academic integration, key components of student retention (Tinto, 1993).

Two more recent studies considered the study of SOC and retention in populations relevant to this investigation. Harris (2007) examined SOC and retention to graduation of a closed-cohort of adult students. Based on Tucker's (1999) findings of a connection between SOC and retention, Harris tracked a closed-cohort, similar to the learning community in this investigation, to determine the factors influencing the creation of community and, in turn, student retention in the program. Community was found to exist in the cohort and was perceived by students to contribute to the completion of the degree program. The most influencing factor on the sense of community of the cohort was the "relationships students formed *with each other*" (Harris, 2007, p. 100). The study generated further possible support for the relationship between SOC and retention in a degree program. Jacobs and Archie (2008) addressed the issue head on by asking "what influence first-year college students' sense of community had on their intent to return to college" (p. 282). Additionally, the investigation sought to identify college variables that influenced SOC. A significant positive relationship was found between SOC and intent to return. New college variables were identified as influencing SOC. In addition to residence and membership in student organizations, employment status and desire to change major were found to be significantly influential on SOC. Jacobs and Archie called for institutions to implement programs that facilitated SOC in first-year students and addressed the need for further investigation into other factors influencing SOC.

Relevance to STEM. Based on previous research by Lounsbury and DeNeui (1995, 1996), DeNeui (2003) conducted a study of the relationship between first-year students' SOC, personality traits, and participation levels. DeNeui found that extroverts scored higher on SOC than did introverts. Though DeNeui had predicted that SOC would increase over the course of the first year, he found that only those students classified as moderate introverts recorded a change in SOC from Time 1 to Time 2. Because engineering students have been predominantly classified as introverts (Felder & Brent, 2005), interventions to increase SOC in this environment could be beneficial. Additionally, DeNeui found that increased involvement on campus resulted in an increase in SOC. This study reinforced the results of Lounsbury and DeNeui (1996) where a positive correlation between extroversion and SOC were found. Furthermore, the author suggested that the quality of the involvement by students was as important, if not more, than the quantity (DeNeui, 2003). Another study conducted almost simultaneously by one of DeNeui's former research partners confirmed the results on extroversion and SOC. Lounsbury, Loveland, and Gibson (2003) studied the "Big Five" (p. 531) personality traits (Neuroticism, Extraversion, Openness, Agreeableness, and Conscientiousness) in relation to SOC in both a high school and college undergraduate population. In both populations, the researchers found that the personality variables were significantly related to SOC and extraversion had a positive correlation to SOC. The question that emerged from Lounsbury et al.'s (2003) research was whether personality, not community variables, was the greater determining factor of SOC since, in this study, 16% of the variance in score was determined by personality – a higher percentage than had been accounted for by community variables in any other study of SOC. If this were the case, then interventions in the community could be further targeted at specific student populations who would benefit most from an increased SOC.

Underscoring the use of SOC in this investigation were findings from Wilson, Spring, and Hansen (2008). Investigating SOC and belonging within engineering, Wilson et al. looked at a number of engineering communities to determine if belonging increased as students' participation became more "central" (p. F3F-22) to the community. Looking at undergraduate students in engineering courses and graduate students participating in an engineering research conference, an engineering research retreat, and a science and technology retreat, the researchers found that as students became more central to the community, or more involved in what was occurring, their belonging and SOC increased. Sophomores in an engineering course, those with the least investment in the community, reported the lowest SOC. Because SOC has been shown to increase in introverts (DeNeui, 2003), a typical personality trait of STEM students, when interventions are applied within the first-year of college and because SOC has been shown to increase when student participation is central to the STEM community (Wilson et al., 2008), community interventions known for influencing SOC that target first-year STEM students should show success in retaining students in the STEM community.

Co-curricular investigations. Co-curricular activities have been the focus of a number of investigations into SOC. Cicognani et al. (2008) looked at three samples of undergraduate students in American, Italian, and Iranian universities and found that SOC was positively correlated with social participation in each population. Using McMillan and Chavis (1986) as their theoretical framework, the researchers found that social participation and SOC were highest among American students. They called for further investigation into the roles of different types of participatory activities and if any one activity influenced SOC at a greater rate than the other (Cicognani et al., 2008).

Looking more specifically at certain types of co-curricular activities, an early investigation conducted by Pretty (1990) examined the SOC of undergraduate students living in an on-campus residence. Using the University Residence Environment Scale [URES] (Moos & Gerst, 1974) and the SCI, she found that the involvement and support constructs on the URES were highly correlated to SOC. Interesting to the current investigation, the URES constructs of independence and competition, common characteristics of STEM environments, were negatively correlated to all four elements of the SCI: membership, influence, fulfillment of needs, and shared emotional connection. Independence was the only one of the two where this relationship was statistically significant. Pretty suggested that future research look into what specific factors of environments affect SOC. In one of the most commonly cited studies on retention, SOC, and residence halls, Berger (1997) took the study a step further. He found that SOC in a residence hall environment was an important link to student persistence which was due to the direct affect of SOC on social integration. His investigation led him to believe that a strong SOC in the residence hall led students to be more engaged in the university community. Berger suggested future research on students' SOC in other small community settings, including academic areas, and how it would affect first-year persistence. He further called for investigation into practices that facilitate or inhibit SOC. In this vein, a recent investigation into SOC and residence halls looked at the affect of residence style or architecture on a student's SOC and how changes in residence hall layouts can change SOC (Devlin et al., 2008). Students in clusters, reflected in most recent construction, were found to have lower SOC than those in traditional residence halls.

Taking residence halls one step further, research on the relationship between SOC and living-learning communities has provided direction and support for the current investigation. Wright (2004), in a study of SOC and living-learning programs (LLP), used the SCI and his original Sense of Community (SSCQ) scale to evaluate the difference in SOC between LLP participants and non-participants. He found that LLP participants had higher SCI scores than did non-LLP participants and that SCI scores varied between the different LLP communities. These findings supported previous research on living-learning communities (LLC) that suggested LLCs were beneficial to students (Pascarella, Terenzini, & Blimling 1994) in a number of areas. Wright further demonstrated with this population that the SCI did not load well along McMillan and Chavis' (1986) four elements of SOC, but that his longer SSCQ could be used as an alternate, more theoretically accurate measure. He recommended that future researchers identify the specific factors that contribute *most* to SOC. In a separate study of African American undergraduates participating in a LLC at a predominantly white institution, though not using SOC as a direct measure, Best (2006) identified SOC as significantly impacting success and retention. She found that advantages provided for retention and the individual experiences for students were reasons to recommend participation in the LLC.

The future recommendations of Wright and the findings of Best lend additional support to an investigation into what aspects of the LLC most affect SOC.

With proven support for the impact of co-curricular activities on student SOC and the use of the construct of SOC to study retention in STEM disciplines, the review of literature stepped back into the broader scope of the university setting. Cheng (2004b) studied specific areas of student life, how students perceive that these areas affect the institution as a community, and the impact of these areas on students' sense of community. The investigation led to three aspects of a student's life that were directly associated with sense of community in the university setting: (a) feelings of being cared about or treated in a caring way by the university, (b) feelings of loneliness on campus, and (c) a quality social life on campus. From these findings Cheng suggested that institution professionals focus on strategic areas to build sense of community. These areas included a common commitment to teaching and learning by both faculty and students, a strong residential experience, nourishment of the campus climate of multiculturalism, and commitment to building history and heritage while creating new rituals and traditions. This investigation posited that the activities of the EXCEL living-learning community fell within the strategic areas suggested by Cheng. Cheng suggested that student involvement enhanced SOC and institution faculty and staff needed to work together to create "a whole learning experience for students" (p. 228). A living-learning community could be just the experience to which Cheng referred. Based on Cheng's suggestions that SOC was enhanced by co-curricular involvement and his recommendation of a whole learning experience, this investigation took Cheng's research one step further to examine student SOC in a whole learning experience, rather than the broader university setting, and explored the co-curricular activities that most influenced the students' SOC.

Conclusion

This review of literature provided a strong foundation on the specific factors in the study of retention that were significant to this investigation. From why the first-year is a critical time in the undergraduate experience to what characteristics are important to student persistence, all have been shown to have strong empirical backing. What is known is that community is important to social integration and social integration is critical to retention in the first-year. Living-learning communities (LLC) are a comprehensive strategy for combating student attrition. LLCs combine best practices from across the institution: active learning pedagogies, student involvement with academics, peers, and faculty, and use of out-of-class, co-curricular activities to name a few. Among those co-curricular activities, Wright (2004) made the case that residence halls were a good place to study SOC. For STEM disciplines, due to diminishing student interest, there is a great need to retain all students, but specifically women and underrepresented minorities. These groups have been shown to connect better where there are communities providing social as well as academic support. They need to feel a part of the community to enhance their chances of success. In addition, it was found that STEM students often possess the personality trait of introversion, a trait that has been shown to be influenced in a positive manner by increasing the student's sense of community. Proven to exist in institutional communities and influence student success, student sense of community (SOC) is a construct useful in studying university environments.

This investigation capitalized on the ways researchers suggested the study of SOC in the university move forward. Lounsbury and DeNeui (1995) and Berger (1997) suggested exploration into the relationship between student attrition and SOC which was the underlying concept in this investigation. In addition, Berger and others (Lounsbury & DeNeui, 1996; McCarthy, Pretty, & Catano, 1990) believed more research should be conducted on the relationship between student SOC and smaller sub-communities including residence hall environments. Cheng (2004b), with support from Tucker (1999), took these recommendations one step further to suggest the creation of a whole learning experience that enhanced student SOC. The study of the EXCEL living-learning community included in this investigation reflected this recommendation. Last, were the suggestions to identify specific factors that contribute most to student SOC (Harris, 2007; Jacobs & Archie, 2008; Pretty, 1990; Wright, 2004). Within these recommendations was where this investigation found its roots.

CHAPTER III
METHODS AND PROCEDURES

Design of the Study

Answering the call for further research of small communities within universities (Cheng, 2004b; Lousbury & DeNeui, 1996; McCarthy, Pretty, & Catano, 1990; Tucker, 1999) and building on the living-learning community work of Buck (2006) and Wright (2004), this study used an adapted version of Cheng's (2004b) sense of community questionnaire to investigate the relationship between a STEM learning community's out-of-class, or co-curricular, activities and students' perceived psychological sense of community to determine which activities most influenced sense of community and, in turn, retention. This chapter includes the following elements: research design, population, instrumentation and issues related to reliability and validity, statistical procedures and analysis, authorization to conduct the study, and data collection procedures.

Quantitative research methodologies were used. Applying a survey method, three separately administered questionnaires were selected to gather self-reported information from students on factors influencing their sense of community. The use of self-administered questionnaires allowed for confidentiality, with the potential for a more honest response. The literature review in Chapter Two provided a basis for factors addressed in this study. The framework for the composition of the questionnaire elements was based on factors derived by Cheng (2004b). Cheng found evidence that "three aspects of a student's college life are directly associated with his or her sense of community" (p. 227). These aspects included students' (a) perceptions that they are cared for, valued as individuals, and belong to the community; (b) feelings of loneliness; and (c) perceived quality of social life which included residential among other experiences. To aid in the collection of data which would accurately address the objectives of this investigation, Cheng's questionnaire was adapted to address these areas within a sub-community rather than the university as a whole. Through the instrument, students provided their perception of activities influencing sense of community specific to the EXCEL program. More in-depth information on the respondents and survey processes were provided throughout the methodology.

Population

The target population for this study was limited to those first-time, full-time, bachelors degree-seeking, science, technology, engineering, and math (STEM) majors entering the University of Central Florida (UCF) in fall 2007 who were selected to participate in the EXCEL program at UCF. All students selected for the EXCEL 2007 cohort were included in this study so no sampling was necessary. The list of students was obtained from the database maintained by the Assessment Committee of the EXCEL program (see Appendix A, Figure 2 for committees).

EXCEL students are chosen through an application and selective admission process. Eligible UCF applicants are encouraged to apply to the EXCEL program. Applicants to EXCEL are solicited via direct mailing strategies beginning in November of each year as well as recruitment at year round university sponsored open houses and college information sessions. Postcards are mailed to the parents of eligible applicants encouraging them to be on the lookout for information regarding the EXCEL program. These are followed by EXCEL recruitment brochures which are sent directly to eligible applicants. Within a week, a follow-up email is sent to the student as a reminder to apply to the program. Subsequent emails follow to non-applicants on a biweekly basis through the end of the recruitment cycle in May of each year. Other recruitment strategies include direct mailings to high school counselors and STEM teachers in the state asking for their assistance in promoting the program to their students.

The EXCEL Advising, Admissions, and Recruitment Committee (AARC) reviews applications and selects participants. The AARC membership includes the EXCEL project co-PI, an undergraduate admissions counselor, and advisors from First Year Advising and Exploration and the discipline areas involved in EXCEL: the Burnett School of Biomedical Sciences, and the Colleges of Science and Engineering and Computer Science. Students are chosen based on their declaration in an EXCEL STEM major, discussed in Chapter One, and SAT mathematics (College Board, 2009) and UCF math placement (University of Central Florida, 2009) scores. The EXCEL program targets students who are good in math and science, have an interest in graduating in an EXCEL STEM discipline, and are seeking additional support in math and science to increase their chances of success in the first two years of college. Overly high achievers in math and science may not find the program of interest due to its structured nature and the fact that math credit earned by advanced placement testing or dual enrollment must be forfeited. This is taken into consideration in the selection process. Students must be ready to begin college level mathematics in the subjects of Pre-Calculus or Calculus I with Analytical Geometry, as determined by the UCF math placement score, in order to be considered for the EXCEL program. The AARC works to ensure a diverse group of students, representing the UCF STEM student body, are selected to participate in the EXCEL program (see Table 6). The AARC has an increased chance of recruiting minorities and women into the EXCEL program by considering the second and third quartiles of the SAT mathematics test which have been traditionally known to capture more students in these populations (Cech, 2008; National Center for Fair & Open Testing, 2007; Roach, 2001). Because government, academia, and industry have called for increasing the number of minorities and women, who have been identified as underrepresented populations in STEM careers (Business Roundtable et al., 2005; BEST, 2003; Matyas & Malcom, 1991; National Academies, 2007; National Science and Technology Council, 2000; National Science Board, 2008b; U. S. Commission on National Security, 2001), factors such as race and gender are considered in addition to discipline of study, math preparation, and term of entry into the university. Unfortunately, some students who are admitted to the EXCEL program choose to withdraw before the semester begins thus causing changes in the demographics between the group admitted and the group that actually participates in EXCEL.

For this investigation, a control group was used to determine if the EXCEL learning community provided any advantage to student success in the first-year. Control group participants, labeled XLC7, were chosen from the 2007 – 2008 freshman entering class at UCF. The first determining factor in the control group selection was discipline of study. Only those students majoring in an EXCEL STEM discipline were selected as part of the control group. From there, the XLC7 group was matched to the 2007 entering EXCEL group on factors such as gender, race, and SAT math score. The fall 2007 EXCEL participants and control group were similarly matched with an average high school GPA of 3.73 and 3.7, respectively.

Table 6.

UCF STEM First-Time in College Population Comparison by SAT Range and Gender and Ethnicity Percentages

Variables	UCF STEM (N = 1842)	Control (N = 824)	EXCEL (N = 174)
SATM Range	320 – 800	550 – 650[a]	520 – 730[b]
Third quartile			
% below	23	---	11
% above	24	---	7
Ethnicity			
White	65[c]	67	64
African American	9[c]	6	8
Asian/Pacific Islander	9[c]	9	6
American Indian/Native	.4[c]	.3	.1
Hispanic	16[c]	16	19
Not specified/other	.6[c]	2	.2
Gender			
Male	65[c]	66	69
Female	35[c]	34	31

Source: University of Central Florida, Office of Institutional Research: EXCEL Assessment Data
[a] The control group was determined after the fall term started and all SAT scores were final thus ensuring the second and third quartiles SAT range (550 – 650). [b] SAT scores falling outside the second and third quartiles (550 – 650) were due to the AARC committee's expansion of the SAT range (530 – 670) to recruit over 200 students. Extreme outliers (over 670) were due to students retesting after EXCEL admission decisions were made. [c] These percentages are for the entire UCF STEM population, not the SATM second and third quartiles.

Instrumentation

Though several have been developed, researchers have not agreed on one best instrument to be used in sense of community (SOC) research. The Sense of Community Index [SCI] (Chavis et al., 1986) is the most commonly used instrument for measuring SOC. Grounded in McMillan and Chavis' (1986) sense of community theory, the SCI was created for evaluation of SOC in a neighborhood (Pretty et al., 1994) and has been adapted for the workplace (Pretty & McCarthy, 1991) and secondary school (Pretty et al., 1994) settings. The reliability coefficients have ranged from .69 to .80 (Pretty & McCarthy). Due to the lack of instruments for the university environment, Lounsbury and DeNeui (1996) created their own Collegiate Psychological Sense of Community scale to accurately measure SOC. Chipeur and Pretty (1999) chastised Lounsbury and DeNeui because their scale was based on items not from the SCI, but when discussing their findings they tried to relate the results to the constructs of McMillan and Chavis' (1986) SOC theory. Berger (1997) adapted the short form of the SCI to the college setting, but used factor analysis to determine the sub-scales because of past research that found the short form sub-constructs to be unreliable (Pretty, 1990). Jacobs and Archie (2008) used the SCI in the study of first-year college students, recreating Berger's (1997) sub-constructs through factor analysis. Despite the wide spread use and adaptation to different environments, some researchers have found weaknesses within the instrument (Chipuer & Pretty, 1999; Meyer, Hyde, & Jenkins, 2005). Chipuer and Pretty found differences in sub-constructs when factor analysis was applied across different communities and suggested a “more robust measure” (p. 655) be developed based on existing strengths and a theoretical foundation. However, they did find that higher SCI scores showed lower levels of loneliness, increased academic ability, and greater social acceptance in adolescents. Meyer, Hyde, and Jenkins (2005) reported that the SCI was not measuring all components of an individual’s SOC and that some critical components were missed. They further believed that the SCI did “not capture SOC at a community-level” (p. 36). Because of the weakness in the instrument and the fact that this investigation did not intend to solely measure a student’s SOC, but instead intended to measure the influence of variables on SOC, the SCI was determined to not be an appropriate instrument.

The web-based survey method used for this investigation was used to identify student perceptions on sense of community. The data used in this study was drawn from two survey instruments for the EXCEL participants and one survey instrument for the control group of non-participants. The first questionnaire was an annual sense of community survey administered to the EXCEL participants and non-participants. The EXCEL Sense of Community (ESOC) questionnaire examined the factors influencing SOC and the students’ perceptions of SOC within the EXCEL community for students participating in the living-learning community. The matched University Sense of Community (USOC) questionnaire examined the factors influencing SOC and the students’ perceptions of SOC within the university community for non-participants. These instruments consisted of 26 closed response questions and took approximately 10 to 15 minutes to complete. Administered via a secure web tool from which only the researcher could retract the data, confidentiality of the students' responses was maintained. The second questionnaire for the EXCEL participants was the EXCEL Applications of Calculus (ACQ) questionnaire which was used to collect information on residence and work habits of students. This questionnaire was administered external to this investigation to all EXCEL 2007 participants during fall 2007.

To reduce response errors and attempt to lower non-response rates, a number of strategies were employed. The researcher followed Dillman's (2000) principles for web questionnaire construction. The number of questions were kept to a minimum and answer categories were pre-coded rather than open-ended. Instructions were simple and the web format was easy to follow with minimal scrolling. Students were only asked to answer questions based on their experiences within a defined period of time, less than seven months in which they were participating within EXCEL. There were no right or wrong answers only responses based on the student's individual perceptions and opinions. Only two questions could be considered invasive or potentially sensitive and have a potential negative effect on responses. With measures for confidentiality, the researcher hoped to reduce this negative effect.

The ESOC and USOC questionnaires were developed after a review of the literature on sense of community in the university. These questionnaires were designed using the sense of community portion of the annual enrolled student survey administered at Columbia University (Cheng, 2004b). The instruments used in this investigation were centered on Cheng's sense of community research which adopted questions from

Janosik's (1991) *The Campus Community Scale*. Cheng's instrument encompasses the theoretical foundation of McMillan and Chavis (1986) and similar concepts of Boyer (Carnegie Foundation, 1990) and Schroeder (1994). With permission of the author (see Appendix B), the survey was adapted to meet the needs of the researcher by measuring perception of sense of community based on the educational activities outlined in the EXCEL program. The inclusion of items on specific educational activities was guided by the review of literature on increasing retention in the first-year described in Chapter Two. Items were reviewed and those unclear or not relevant to this study were reworded or removed. Each item was then reconfigured to address the EXCEL population directly. For the USOC questionnaire, the same process was followed for adjusting or removing items not relevant to this study, however, the reference to the University community was left intact for this group. The items for both questionnaires were submitted to an expert panel for content review. Suggested revisions were implemented. Further detail on the content review is detailed in the following section. The 26 item ESOC questionnaire (see Appendix C) was designed to assist administrators in better understanding students' perceptions of the impact of EXCEL educational activities, students' level of satisfaction with what is offered (Cheng, 2004b), and the role these activities play in enhancing student perception of sense of community. Responses were constructed on a four-point Likert Scale (Gay & Airasian, 2003; Likert, 1932) where 4 = strongly agree and 1 = strongly disagree. A forced choice method, omitting "neither agree or disagree", was determined to be the best approach for this investigation. Students are then required to choose a level of agreement or disagreement with the statement. In the absence of a neutral category, students were provided with the option of “not applicable” on questions 5, 6, 8, 9, 10, 12, and 16 where the scenario may not have applied to their situation. Question 8, “I have felt lonely at UCF”, and Question 23, “I often felt under a lot of stress during my time at this institution”, were negatively-keyed and were reverse-scored prior to analysis. The 26 item USOC questionnaire (see Appendix D) followed the same design using the university community rather than the EXCEL community as a point of reference. It is this data along with institutionally provided demographic and academic data that were under analysis.

Reliability and Validity

Reliability of an instrument is the accuracy, precision, or consistency by which that instrument measures something (Kerlinger, 1986). Instruments using more than two scores, similar to the Likert scale (e.g. 1, 2, 3, 4) used in this investigation, often use a Cronbach’s Alpha (Cronbach, 1951) to determine internal consistency reliability (Gay & Airasian, 2003) in the score produced. Internal consistency reliability is commonly used when dealing “with one test at one time” (p. 143). Using the approach of a one test administration decreases the likelihood of measurement or random errors (Gay & Airasian). Cronbach’s Alpha is an estimate of internal consistency reliability. This is determined by “how all items on a test relate to all other test items and to the total test” (p. 144). Items measuring similar concepts are deemed to be internally consistent. Using the standards of the University of Central Florida’s Dr. Stephen Sivo, a Cronbach’s

Alpha greater than .80 was considered to be very good, between .65 and .80 only modest, and below .65 poor reliability existed. Though Cheng (2004b) provided no Cronbach's Alpha on the original instrument, all independent items, with the exception of one, reflected significant correlations with the dependent variable. Similar correlations were provided for the adapted ESOC instrument items as well as a Cronbach's Alpha to test internal consistency reliability of the scores.

For content validity, "the degree to which a test measures an intended content area" (Gay & Airasian, 2003, p. 136), to exist an instrument should be congruent with the goals of the study (Haynes & O'Brien, 2000). Therefore, in this investigation the instrument needed to measure the variables identified by EXCEL as important to the students' SOC. Because the ESOC instrument used in this investigation was adapted from Cheng's (2004b) instrument, which had already been used in a university environment, there was no concern over the relevance to the setting. No pretest of the survey was conducted because Cheng's instrument had previously been shown to be valid for determining significant relationships between student's SOC within a university population and the individual items of the survey. In addition, the adapted ESOC instrument was reviewed by an expert panel to further determine content validity. A list of the reviewers and their areas of expertise were provided in Table 20 (see Appendix E).

Gay and Airasian (2003) identified construct validity as the most important type of validity because construct validity gets at what the instrument is really measuring. Constructs are "non observable traits" (p. 139) underlying the variables measured. The investigation is only valid if the “instrument used actually measures the intended construct” (p. 139). The intended constructs for this investigation were determined from an extensive literature review in the fields of retention and SOC as well as previous research conducted with the instrument from which the ESOC was adapted. These constructs are place of residence and the EXCEL Center, representing a quality social life on campus, and students’ social integration representing Cheng’s (2004b) feelings of being cared about or treated in a caring way by the university and feelings of loneliness on campus. Factor analysis was used to test the existence of these underlying constructs further supporting the construct validity of the instrument used.

Statistical Procedures

The independent, dependent, and control variables are introduced then each discussed in detail. A breakdown of the instrument items and procedures used is provided for each research question.

Variables

The variables examined in this investigation included three dependent variables (sense of community, retention, and math on-track) and an initially unidentifiable number of independent variables. Through factor analysis, this investigation identified a set of independent variables that have been found throughout the literature to influence SOC. This investigation sought to determine the students’ perceptions of those independent variables in the EXCEL environment and to determine the relationship between those independent variables and the dependent variable of student SOC. Additionally, the investigation attempted to determine differences in the dependent variables of retention and math on-track between those participating and not participating in the treatment, the EXCEL learning community.

Dependent Variables

Developing a sense of community (SOC) is an important component to the social integration and ultimate retention of students in a university setting (Bailey, Bauman, & Lata, 1998; Berger, 1997; Buck, 2006; Cheng, 2004b; Ke, 2006; Lounsbury & DeNeui, 1996; Rovai, 2002a; Sanders, Basham, & Ansburg, 2006; Tinto, 1993; Wright, 2004). McMillan and Chavis (1986) defined sense of community as members belonging, mattering to one another, and meeting personal needs through commitment to the group. Boyer (Carnegie Foundation, 1990) and Schroeder (1994) integrated similar elements in support of the sense of community in a collegiate environment and specifically within a learning community. The focus on increased SOC is to increase the likelihood of retention within the university and for this investigation, within the STEM discipline. Using SOC as the dependent variable, differences in SOC and their influences were investigated within the EXCEL learning community. Further investigation looked into SOC influences and differences between the EXCEL participants and non-participants.

The first-year, even the first few weeks, of college is a critical time for retaining students (Boyer, 1987; Levitz & Noel, 1989, 2000; Noel, 1985; Ryan & Glenn, 2003; Tinto, 2001; Tinto & Goodsell, 1993; Upcraft, Gardner, & Associates, 1989). During this period, students are most vulnerable (Cuseo, 2007; Mortenson, 2005). More than half of the students who ultimately withdraw from an institution do so during this time (Cuseo, n.d., 2007; Terenzini & Reason, 2005; Tinto, 1987, 2001). Living-learning communities like EXCEL are a proven strategy for increasing first-year retention (Laufgraben, 2005; MacGregor et al., 2002; Tinto & Goodsell, 1993). The differences, if any, in retention between participants and non-participants of the EXCEL program were explored in this investigation by looking at retention to the discipline in the first-year of college and being on-track in mathematics after the first-year as dependent variables.

Independent Variables

Two sets of independent variables were considered in this investigation: one for the investigation into SOC and another for the investigation into retention. The independent variables to the key investigation of SOC were determined by factor analysis conducted on responses to the ESOC. Based on an extensive literature review and careful instrument construction, these variables were expected to align with the EXCEL out-of-class educational activities. The three broad categories expected consist of: place of residence, the EXCEL Center, and student social integration. These variables align with Cheng's (2004b) three aspects of a student's life that were directly associated with sense of community in the university setting. Feelings of being cared about or treated in a caring way by the university and feelings of loneliness on campus align with students' social integration. Place of residence and the EXCEL Center align as components of a quality social life on campus. The independent variable considered in the investigation into retention and math on-track was participation or non-participation in the EXCEL learning community.

Control variables

Control variables are those variables which are not manipulated (Gay & Airasian, 2003) or are not of interest to the primary investigation, but may have some significance in influencing the outcome (Shavelson, 1996). These may be physical or mental characteristics. When examining the dependent variable of SOC this investigator controlled for background demographics and college academic characteristics, both of which have a potential affect on student success outcomes including retention (Astin, 1970; Braxton, Hirschy, and McClendon, 2004; Braxton & Lee, 2005; Nora, 2004; Pascarella, 1985; Tinto, 1993; Weidman, 1989). Background characteristics included gender, race, SAT scores, and high school GPA. Each of these individual items has been identified to influence student success in previous research (Astin, 1970; Tinto, 1993; Zhang, Thorndyke, et al., 2002) and was of importance to the population under investigation. College academic characteristics included student's specific STEM major, first semester GPA, and first-year cumulative GPA, again, each of which have been identified to influence student success in previous research (Desjardins, Kim, & Rzonca, 2003; Fenske et al., 2000; Hotchkiss, Moore, & Pitts, 2006; Ohland et al., 2008; Zhang, Thorndyke, et al., 2002) and were of importance to the population under investigation. An additional control variable used was the math section in which students were enrolled. This allowed the researcher to control for any bias based on the level of math placement or the individual instructors and their associated teaching style, factors which are known to influence student success (Braxton, Bray, & Berger, 2000; Braxton, Milem, & Sullivan, 2000; Tinto, 1997). The final control variable used was place of residence. Residence life has consistently been shown to enhance student life on campus including sense of community (Astin, 1993; Hughes, 1994; Pascarella, Terenzini, and Blimling, 1994; Pike, 1999; Pike, Schroeder, & Berry, 1997; Schroeder, 1994; Upcraft, 1989a; Zeller, 2005).

Research Questions

Research Question 1

1. What relationship, if any, exists between the educational activities of the EXCEL program and the psychological sense of community perceived among the students participating in the EXCEL program?

The educational activities of the EXCEL program under investigation included the co-curricular elements of the living-learning community. Specifically, this investigation explored the relationships between SOC and place of residence, the EXCEL center, and the social integration of the participants. All 26 items of the ESOC instrument were used to determine these relationships. Items 1 through 25 (see Appendix C) were used as independent variables while item 26 served as the dependent variable. A Pearson's Product Moment Correlation (Pearson's ρ) was calculated to determine the correlation between the interval data elements of the population (Gay & Airasian, 2003). Gay and Airasian's suggested interpretation, a "coefficient below plus or minus .35 [will be considered], low or not related; coefficient between plus or minus .35 and .65, moderately related; and coefficient higher than plus or minus .65 highly related" (p. 413) was used with a minor adjustment. Affective instruments may use .60 as highly related due to the tendency for these instruments to have lower validities (Gay & Airasian).

Research Question 2

2. What underlying dimensions, if any, exist within the EXCEL experience and what are their relationships to a student's perceived sense of community?

Items 1 through 25 of the ESOC instrument were used in a confirmatory factor analysis with an oblique rotation to determine the underlying constructs. Using Kaiser's (1960) rule, those factors with an eigenvalue of 1.0 or higher were determined to be the extracted factors. The identified constructs were then examined, through multiple regression, as to their relationship to sense of community with item 26 serving as the dependent variable. A R^2 was calculated to determine the variance in the dependent variable accounted for by the set of independent variables.

Research Question 3

3. What relationship, if any, exists between the first-year retention of EXCEL participants and their perceived sense of community?

Data provided by the Office of Institutional Research (OIR) was used to determine the first-year retention of participants in the EXCEL program. The relationship between retention and sense of community was examined with item 26 from the ESOC instrument used as the independent variable and retention as the dependent variable. The relationship was determined using a Chi Square (χ^2) statistic.

Research Question 4

4. What differences, if any, exist in the educational profile of first-year EXCEL participants and non-participants?

Data provided by OIR was used to determine the background and academic variables, math section, place of residence, and participation or non-participation in EXCEL. Differences in sense of community (SOC) were explored by applying the ESOC factors to the University Sense of Community (USOC) responses and running independent t tests between the EXCEL participants and non-participants. For both retention and math on-track Chi-square (χ^2) analysis and two-sample independent t tests were conducted to explore differences. The final piece consisted of providing a set of descriptive statistics of the two groups, EXCEL participants and non-participants, and looking for differences in their first semester and cumulative first-year GPAs.

Statistical Analysis

The primary focus of this research was to investigate the relationship between the out-of-class educational activities of a living-learning community designed for STEM students and the students' perceived psychological sense of community (SOC) and to determine which activities most influenced sense of community and, in turn, retention. Tinto (1993) and Braxton, Hirschy, and McClendon's (2004) work on retention, social integration, and the aspect of community coupled with McMillan and Chavis' (1986) work on psychological sense of community served as the theoretical foundation on which this investigation was based.

Over time, research on students has become more complex with investigators determining that many factors influence a student's decision to persist and their sense of community. Due to this fact, a common statistic for more recent work (see examples Cheng, 2004b; DesJardins et al., 2003; McCarthy et al., 1990; Zhang et al., 2002) has been multiple regression. Through this approach a researcher can investigate which characteristics, attributes, or variables influence retention and to what extent. Researchers can look at many variables simultaneously, rather than one at a time, to determine an effect. By determining the R^2, one determines the total variance in the dependent variable associated with a particular factor or set of factors, thus determining the magnitude of the relationship (Gay & Airasian, 2003). When these factors are unknown, exploratory techniques based in a theoretical framework will be used. Factor analysis is a common technique used to determine if constructs or factors can be ferreted out or confirmed and associated with the dependent variable, in this case sense of community.

An extensive data analysis process was necessary to answer the research questions for this investigation. The proposed questions address the relationship and underlying dimensions within the EXCEL experience related to students' perceived sense of community and the existence of differences in success between the EXCEL participants and non-participants. This investigation used descriptive statistics, along with correlations, factor analysis, and multiple regression. Each is described in some detail.

An ex post facto design (Shavelson, 1996) was used to determine possible relationships between out-of class activities and sense of community within the EXCEL program. This design is used “to describe relationships between two [or more] variables” (p. 26) when measurements are taken “after the treatment has been administered” (p. 26). No causal relationships can be determined, only relationships. In this instance, the EXCEL living-learning community was the treatment applied and the measurement was the students’ perception of sense of community and its influencing factors at the end of the first-year of the program.

A descriptive analysis of the ESOC responders and non-responders was provided. Additionally, student responses to the individual aspects of their EXCEL or college experience as well as the relationship between each individual activity and the students’ sense of community was shown. The relationship between items was revealed through correlation, which provides “a quantitative measure of the degree of correspondence between two or more variables” (Gay & Airasian, 2003, p. 11). The problem with correlations is that they are approximations and what may be acceptable in one situation may not be acceptable in another. Along with this, a Cronbach’s Alpha was calculated to show reliability of the instrument.

For the primary component of this research, investigating sense of community, factor analysis was performed to identify existing underlying dimensions and the relationship with the students’ sense of community. A reliability analysis was conducted for each construct identified in the factor analysis. Hierarchical multiple regression (Shavelson, 1996) was conducted to determine the association to SOC of the control and independent variables, identified through factor analysis, within the EXCEL community.

Using this method, two groups of control variables and two item controls, determined important by the review of literature, were entered into the model, followed by the factors identified through factor analysis. Tests for multi-collinearity, to determine whether correlation existed between the independent variables, were conducted before entering variables into the regression model.

A two-group quasi-experimental design (Shavelson, 1996) with a no-treatment control group was used to determine differences, if any, and create a profile of EXCEL participants and non-participants. A quasi-experimental design includes a control group and is used when random assignment is not feasible (Shavelson), as was the case in this investigation. A control group is a group of subjects, similar to the experimental group, who are selected and treated no differently than the experimental group except that they do not receive the treatment (Shavelson). Utilizing a control group helps to control for internal validity. Both components of the current investigation are between subject designs (Cone & Foster, 2006) due to the fact that any variation found is between subjects at a given point in time, not within the same subject over a given period of time or different situations.

For the secondary component of this research, comparisons between the EXCEL participants and non-participants were executed to determine if significant differences existed between the groups in SOC and student success through the first-year as measured by retention in the discipline and being on-track in mathematics. The use of the independent t test and chi-square test of independence were conducted for SOC, retention, and math on-track.

Authorization to Conduct the Study

The EXCEL program has been approved by the IRB to conduct associated research (Appendix F) and specifically received approval for the ESOC instrument used in this investigation. Upon entering the EXCEL program, students provided informed consent (Appendix G) to participate in measurement activities relevant to the program.

IRB Application Process

Before beginning the data collection, the researcher completed the necessary process identified by the Institutional Review Board (IRB) for conducting research on human subjects. The IRB process required the researcher to submit information regarding (a) the purpose of the investigation, (b) the methodology used, and (c) the statistical analysis that would be performed. Questions on the data collection process and the involvement of human subjects were completed to help determine the impact the investigation would have on the targeted population. The initial submission was then approved by the researcher's faculty advisor and department chair. After an initial review, clarification was requested on the data being used for the research. The researcher submitted more detailed information on the use of institutional data and the original intent of the data collected for the EXCEL program in spring 2008. With this clarification, the investigation was determined to be "minimal risk for human subjects" and permission was granted to conduct the study (see Appendix H).

Any time researchers deal with student academic records issues of confidentiality arise. The researcher is bound by all regulations under the Federal Educational Rights and Privacy Act [FERPA] (1974) to protect confidentiality and security of student records. Student data was kept on a secured university server in a private, password protected folder and viewed only through a secure network. Instrument information was not anonymous, but was identifiable at the student level to the researcher only. No student information was passed to any party outside of the research team. Aggregate data alone was reported under this investigation.

Originality Score

The University of Central Florida (UCF) College of Graduate Studies requires each student completing dissertation or thesis to submit their work for originality. The method of choice for UCF Graduate Studies is the tool Turnitin (iParadigms, 2009). An acceptable score defined by the graduate advisor for this investigation was between zero and ten percent. Upon initial submission, the researcher received a score of 29%. With removal of bibliographic and quoted material the score moved into the acceptable range at 7%. An item by item review allowed for a further reduction in the total score. The document was approved as original work by the researcher's graduate advisor.

Data Collection Plan

Consideration was given to the time constraints and confidentiality of the respondents. To accommodate busy student schedules and ensure the accuracy of data, demographic and academic information that had been previously collected or was recorded by the institution was used. Institutional data was provided by the Office of Institutional Research (OIR) at UCF. Data elements from OIR included all previously defined background and academic characteristics in addition to information which was used to determine retention and being on-track in mathematics. All regulations under the Federal Educational Rights and Privacy Act [FERPA] (1974) to protect confidentiality and security of student records were followed. Student data was kept on a secured university server in a private, password protected folder and viewed only through a secure network.

As part of the EXCEL assessment process, the ACQ was completed in the Applications of Calculus and Pre-Calculus classes during the last class meeting prior to the final exam during the fall of 2007. Students were given a short pencil and paper questionnaire where they were asked to assess the course and provide two pieces of demographic information. Data collected from the ACQ that was used in this investigation included the demographic information place of residence including its association to the EXCEL program. The data was retrieved from the EXCEL Assessment Committee for use in this investigation.

The 174 EXCEL students were solicited for feedback on the ESOC questionnaire. These students represented three undergraduate colleges: the College of Engineering and Computer Science (CECS), College of Medicine (COM), and College of Sciences (COS). There were 133 (76%), 8 (5%), and 33 (19%) students from each college, respectively. Though not exact, these proportions were representative of the proportions of EXCEL

STEM populations in each college at UCF (see Chapter 1, Table 1). The control group included 824 students who were each solicited for feedback on the USOC questionnaire. These students represented the same three colleges with 438 (53%), 158 (28%), and 228 (19%) being from CECS, COM, and COS, respectively. The control group was more representative of the total UCF EXCEL STEM population amongst the colleges than the EXCEL cohort. Discrepancies were most likely due to greater solicitation for EXCEL applicants within the College of Engineering and Computer Science and the fact that 2007 was the first year the College of Medicine participated in the program.

The ESOC and USOC instruments were Web based. Two web sites, one for each questionnaire, were created and Form Manager software (i2-Services, Inc., 2008) was employed to collect the responses. Initial contact was made via e-mail (see Appendices I & J) during the students' second semester of enrollment in late March of 2008. Students were instructed that their participation was voluntary. Students were further notified that their questionnaire responses were not anonymous, but were instead confidential, identifiable at the student level to the researcher only, and that their responses would only be summarized to get a more accurate picture of the larger EXCEL group. No student information was passed to any party outside of the research team and aggregate data alone was reported under this investigation.

To encourage a timely response and to attempt to increase the response rate, students were informed of the opportunity to be included in a drawing for one of eight $25 bookstore gift cards and one of two one-semester textbook scholarships. Prizes were donated by the EXCEL program and the College of Engineering and Computer Science. Students were entered once the completed survey was submitted online. Attempts were made to contact all students who started UCF in Fall 2007, but may not have been enrolled in Spring 2008. For the EXCEL students, the initial e-mail was followed by visits from the researcher to the EXCEL Applications I and II courses. Responses were compared with the master EXCEL and control group lists at weekly intervals. Follow up e-mails were sent on this same weekly basis to non-respondents from both groups for four weeks. The specific calendar dates of the mailings were March 21 and 26, then again on April 3, 8, and 16. Keeping in mind Dillman's (2000) contact checklist, each e-mail was adjusted to address the situation at hand: notice, reminders, response requested, and final contact. At the end of the collection period in mid April, all participants were thanked for their participation and winners of the drawings were announced via e-mail.

CHAPTER IV
DATA ANALYSIS AND FINDINGS

This investigation consisted of two primary areas: the relationship of the educational activities to sense of community within the EXCEL program and the differences, if any, in the educational profile between EXCEL participants and non-participants. Four research questions guided the investigation. The outline of this chapter was structured into two parts around the primary areas of investigation and four sections around the research questions. Preceding each primary area is an introductory conversation on the population used for the specific question or questions of the investigation. Each section consists of the question with a description of the step-by-step process into the investigation on that question.

Part One – EXCEL Cohort

Part one of the investigation, sense of community within EXCEL, was addressed by research questions one through three. Each question used the EXCEL Sense of Community (ESOC) questionnaire in the analysis. From the 174 EXCEL participants who were solicited, there were 114 responses to the survey. Five were found to be duplicates and one was a non-EXCEL participant. These responses were removed prior to analysis. Of the 174 students surveyed, 108 of them (62% of the targeted population) responded to the questionnaire. Demographics on the responders versus the non-responders were provided in Table 7. All categories of the ESOC respondents, except for males (63% vs. 80%), were over represented in comparison to the non-responders. The responders also included more of the outliers in the SAT math scores ranging from 520 to 720 versus the non-responders who ranged only from 530 to 670.

Table 7.

Demographics Comparison of ESOC Responders and Non-responders

Gender/Race	Responders	Non-responders
Female	40 (37)[a]	13 (20)
Male	68 (63)	53 (80)
White	64 (59)	47 (71)
African American	11 (10)	3 (4)
Hispanic	22 (21)	11 (17)
Asian/Pacific Islander	8 (7)	3 (5)
Other[b]	3 (3)	2 (3)
SAT Range	520 – 720	530-670

[a] Percentages of the total responder and non-responder populations were calculated for each item and shown in parenthesis. [b] Represents groups without significant numbers for comparison: American Indian, Non-Resident Alien, and Not Specified.

The reliability of the scores produced by the instrument used to measure sense of community needed to be established before additional analysis on the data could be completed. Though used previously in a university setting (Cheng, 2004b), the adaptation from the university to the sub-community environment required additional analysis to confirm previous results. Statistical Package for the Social Sciences [SPSS] (SPSS Inc., 2009) was used in this and all other statistical analysis. Each of the 26 items of the ESOC questionnaire was entered into SPSS for all respondents. Respondent ratings on the items from the ESOC questionnaire were judged to be very reliable for the EXCEL group to whom it was given, with a reliability coefficient (Cronbach's Alpha) $\alpha = .835$. The alpha was based on 96 cases, using a listwise deletion built on all variables, and all 26 items. By reviewing the corrected item-total correlation, removal of additional items could increase the alpha even higher. The items RHAWARER, RHSOBELNG, OFFINCLUDE, and FELTLONELY all reflected item correlations less than .100. The researcher chose to leave them intact due to the importance of the items to the other research questions. Three of the items were regarding place of residence. Previous research (Astin, 1975, 1977, 2006; Beckett & Marrero, 2005; Berger, 1997; Boyer, 1987; Braxton, 2003; Chickering, 1974; Christie & Dinham, 1991; Gandhi, 2000; Johnson, Soldner, and Inkelas, 2006; Kuh et al., 1991; Pascarella & Terenzini, 1991; Pascarella, Terenzini, & Blimling, 1994; Pike, 1999; Pike, Schroeder, & Berry, 1997; Upcraft, 1989a; Skahill, 2003; Wright, 2004) found place of residence to be an important influence on student success and it was a primary area of interest to this investigation due to the living-learning community environment established by EXCEL. The final item, feeling lonely, was found by Cheng (2004b) to have a negative influence on SOC so was left in for comparison. Therefore, due to the very strong reliability coefficient based on all 26 items and the potential importance of the low correlation items to the remaining research questions, no items were removed from the instrument.

Research Question One

The first question was, *What relationship, if any, exists between the educational activities of the EXCEL program and the psychological sense of community perceived among the students participating in the EXCEL program?* Based on the findings of previous literature on sense of community [SOC] (Cheng, 2004b; Harris, 2007; Jacobs & Archie, 2008; Lounsbury & DeNeui, 1996; McCarthy, Pretty, & Catano, 1990; Pretty, 1990; Wright, 2004), it was expected that a relationship would exist between the educational activities of the EXCEL program and the SOC perceived among the EXCEL participants. This research question was addressed by conducting a Pearson's Product Moment correlation between each item, 1 through 25, of the ESOC and the student's perceived sense of community as determined by item 26 of the ESOC. All items were rated on a scale of 1 to 4 with 4 equal to strongly agree and 1 equal to strongly disagree. In the absence of a neutral category, *not applicable,* was an answer option on questions 5, 6, 8, 9, 10, 12, and 16 and was identified as missing data on those questions so as to not skew the analysis results.

Item one asked participants to agree or disagree with the statement *Students in the EXCEL program care about each other*. The results indicated a statistically significant relationship between sense of community and students caring about one another ($r = .559$, $p < .01$). Slightly more than 31% of the variance in sense of community and students caring about one another was shared, leaving 69% unexplained by the relationship. A positive moderately strong relationship existed revealing students who showed positive responses to caring about each other also showed positive responses on perceived sense of community.

Item two asked participants to agree or disagree with the statement *I feel valued as a person within EXCEL.* The results indicated a statistically significant relationship between sense of community and feeling valued as a person ($r = .557$, $p < .01$). Slightly more than 31% of the variance in sense of community and feeling valued as a person was shared, leaving 69% unexplained by the relationship. A positive moderately strong relationship existed revealing students who showed positive responses to feeling valued as a person also showed positive responses on perceived sense of community.

Item three asked participants to agree or disagree with the statement *I feel accepted as part of the EXCEL community*. The results indicated a statistically significant relationship between sense of community and feeling accepted in the EXCEL community ($r = .520$, $p < .01$). Slightly more than 27% of the variance in sense of community and feeling accepted was shared, leaving 73% unexplained by the relationship. A positive moderately strong relationship existed revealing students who showed positive responses to feeling accepted in the EXCEL community also showed positive responses on perceived sense of community.

Item four asked participants to agree or disagree with the statement *Faculty associated with this program care about students*. The results indicated a statistically significant relationship between sense of community and faculty caring about students ($r = .344$, $p < .01$). Only approximately 11% of the variance in sense of community and faculty caring was shared, leaving 89% unexplained by the relationship. A positive, low level of relationship existed revealing students who showed positive responses to faculty caring may showed positive responses on perceived sense of community.

Item five asked participants to agree or disagree with the statement *EXCEL Center programs foster positive relationships among the EXCEL participants*. Because student academic support centers were co-curricular activities that found support in the literature for enhancing student success (Boyer, 1987; Brannan & Wankat, 2005; Braxton & Mundy, 2002; Kuh et al., 2005; Laufgraben, 2005; Smith et al., 2004; Zheng et al., 2002) the expectation was that a relationship would exist. The results indicated a statistically significant relationship between sense of community and the EXCEL Center fostering positive relationships (r =.517, $p < .01$). Approximately 27% of the variance in sense of community and the EXCEL Center fostering positive relationships was shared, leaving 63% unexplained by the relationship. A positive moderately strong relationship existed revealing students who showed positive responses to the EXCEL Center fostering positive relationships also showed positive responses on perceived sense of community.

Item six asked participants to agree or disagree with the statement *Living in the residence halls has raised my awareness of campus resources*. The results indicated a statistically significant relationship between sense of community and residence halls raising awareness of campus resources (r =.250, $p < .05$). Only approximately 6% of the variance in sense of community and residence halls raising awareness of campus resources was shared, leaving 94% unexplained by the relationship. A minimal positive relationship, if any, existed revealing students who showed positive responses to residence halls raising awareness may or may not showed positive responses on perceived sense of community.

Item seven asked participants to agree or disagree with the statement *The institution's traditions and celebrations play an important role in my life as a student*. The results indicated a statistically significant relationship between sense of community and university traditions (r =.248, $p < .01$). Only approximately 6% of the variance in sense of community and university traditions was shared, leaving 94% unexplained by the relationship. A minimal positive relationship, if any, existed revealing students who showed positive responses to university traditions may or may not showed positive responses on perceived sense of community.

Item eight asked participants to agree or disagree with the statement *I have felt lonely at UCF*. The results indicated no statistically significant relationship between sense of community and feelings of loneliness at UCF (r =.083, $p = .402$).

Item nine asked participants to agree or disagree with the statement *My experience living in the EXEL residence hall has increased my sense of belonging*. The expectation was that this item would concur with the abundance of literature that reinforces the residence hall as having a positive effect on student success including those studies specific to the STEM disciplines (Beckett & Marrero, 2005; Gandhi, 2000; Hildreth & Brown, 2007; Johnson, Soldner, and Inkelas, 2006). The results indicated a statistically significant relationship between sense of community and the EXCEL residence hall increasing sense of belonging (r =.672, $p < .01$). Slightly over 45% of the variance in sense of community and the EXCEL residence hall increasing sense of belonging was shared, leaving only 55% unexplained by the relationship. A positive very strong relationship existed revealing students who showed positive responses to the EXCEL residence halls increasing sense of belonging also showed positive responses on perceived sense of community.

Item ten asked participants to agree or disagree with the statement *I live off campus and feel included in the EXCEL community*. The results indicated a statistically significant relationship between sense of community and feeling included even though living off-campus (r =.418, $p < .05$). Slightly over 17% of the variance in sense of community and feeling included though off-campus was shared, leaving 83% unexplained by the relationship. A positive moderately strong relationship existed revealing students who showed positive responses to feeling included though living off-campus also showed positive responses on perceived sense of community.

Item eleven asked participants to agree or disagree with the statement *I am satisfied with the range of extracurricular activities offered at UCF*. The results indicated a statistically significant relationship between sense of community and availability of UCF extracurricular activities (r =.360, $p < .01$). Almost 13% of the variance in sense of community and satisfaction with availability of UCF extracurricular activities was shared, leaving 87% unexplained by the relationship. A positive moderately strong relationship existed revealing students who showed positive responses to availability of UCF extracurricular activities may also showed positive responses on perceived sense of community.

Item twelve asked participants to agree or disagree with the statement *The EXCEL Center allows me to interact with students like me.* The results indicated a statistically significant relationship between sense of community and the EXCEL Center interaction with like students (r =.509, $p < .01$). Approximately 26% of the variance in sense of community and the EXCEL Center allowing for interaction with other students was shared, leaving 64% unexplained by the relationship. A positive moderately strong relationship existed revealing students who showed positive responses to the EXCEL Center allowing interaction with like students also showed positive responses on perceived sense of community.

Item thirteen asked participants to agree or disagree with the statement *I am satisfied with the range of extracurricular activities available within EXCEL.* The results indicated a statistically significant relationship between sense of community and the availability of EXCEL extracurricular activities (r =.223, $p < .05$). Only approximately 5% of the variance in sense of community and availability of EXCEL extracurricular activities was shared, leaving 95% unexplained by the relationship. A minimal positive relationship, if any, existed revealing students who showed positive responses on availability of EXCEL extracurricular activities may or may not have shown positive responses on perceived sense of community.

Item fourteen asked participants to agree or disagree with the statement *EXCEL faculty and students work together to promote my learning.* The results indicated a statistically significant relationship between sense of community and faculty and students working together to promote learning (r =.471, $p < .01$). Slightly over 22% of the variance in sense of community and faculty and students working together to promote learning was shared, leaving 78% unexplained by the relationship. A positive moderately strong relationship existed revealing students who showed positive responses to faculty and students working together to promote learning also showed positive responses on perceived sense of community.

Item fifteen asked participants to agree or disagree with the statement *EXCEL faculty are accessible to me when I seek their help.* The results indicated a statistically significant relationship between sense of community and EXCEL faculty accessibility (r =.300, $p < .01$). Only approximately 9% of the variance in sense of community and EXCEL faculty accessibility was shared, leaving 91% unexplained by the relationship. A minimal positive relationship, if any, existed revealing students who showed positive responses on EXCEL faculty accessibility may or may not showed positive responses on perceived sense of community.

Item sixteen asked participants to agree or disagree with the statement *The EXCEL Center provides services that enhance my academic success.* The results indicated a statistically significant relationship between sense of community and Center services enhancing success (r =.453, $p < .01$). Slightly over 20% of the variance in sense of community and the Center services enhancing success was shared, leaving 80% unexplained by the relationship. A positive moderately strong relationship existed revealing students who showed positive responses to the Center services enhancing success also showed positive responses on perceived sense of community.

Item seventeen asked participants to agree or disagree with the statement *EXCEL graduate students are accessible to me when I seek their help.* The results indicated a statistically significant relationship between sense of community and EXCEL graduate student accessibility (r =.368, $p < .01$). Approximately 14% of the variance in sense of community and EXCEL graduate student accessibility was shared, leaving 86% unexplained by the relationship. A minimal positive relationship existed revealing students who showed positive responses on EXCEL graduate student accessibility may also showed positive responses on perceived sense of community.

Item eighteen asked participants to agree or disagree with the statement *EXCEL allows me to interact with people of different backgrounds.* The results indicated a statistically significant relationship between sense of community and interaction with diverse students (r =.412, $p < .01$). Approximately 17% of the variance in sense of community and interaction with diverse students was shared, leaving 83% unexplained by the relationship. A positive moderately strong relationship existed revealing students who showed positive responses to interaction with diverse students also showed positive responses on perceived sense of community.

Item nineteen asked participants to agree or disagree with the statement *I am proud of this institution's history and heritage.* The results indicated a statistically significant relationship between sense of community and UCF historical pride (r =.304, $p < .01$). Only approximately 9% of the variance in sense of community and UCF historical pride was shared, leaving 91% unexplained by the relationship. A minimal positive relationship, if any, existed revealing students who showed positive responses on UCF historical pride may or may not have shown positive responses on perceived sense of community.

Item twenty asked participants to agree or disagree with the statement *My friends share my interests and values.* The results indicated a statistically significant relationship between sense of community and friends sharing interests and values (r =.438, $p < .01$). Slightly over 19% of the variance in sense of community and friends sharing interests and values was shared, leaving 81% unexplained by the relationship. A positive moderately strong relationship existed revealing students who showed positive responses to friends sharing interests and values also showed positive responses on perceived sense of community.

Item twenty-one asked participants to agree or disagree with the statement *The EXCEL curriculum has made me interested in the study of math and science.* The results indicated a statistically significant relationship between sense of community and the EXEL curriculum sparking an interest in math and science (r =.456, $p < .01$). Slightly over 20% of the variance in sense of community and the EXEL curriculum sparking an interest in math and science was shared, leaving 80% unexplained by the relationship. A positive moderately strong relationship existed revealing students who showed positive responses to the EXEL curriculum sparking an interest in math and science also showed positive responses on perceived sense of community.

Item twenty-two asked participants to agree or disagree with the statement *I am satisfied with the overall quality of instruction within the EXEL program.* Both active learning concepts and faculty teaching skills which have been found to increase students' social integration and, ultimately, retention (Braxton, Bray, & Berger, 2000; Braxton, Milem, & Sullivan, 2000), were covered in the EXCEL faculty development program so the expectation was that a relationship would exist. The results indicated a statistically significant relationship between sense of community and satisfaction with the quality of instruction (r =.529, $p < .01$). Approximately 28% of the variance in sense of community and satisfaction with the quality of instruction was shared, leaving 72% unexplained by the relationship. A positive moderately strong relationship existed revealing students who showed positive responses to satisfaction with the quality of instruction also showed positive responses on perceived sense of community.

Item twenty-three asked participants to agree or disagree with the statement *I often felt under a lot of stress during my time at this institution.* The results indicated no statistically significant relationship between sense of community and feelings of stress at UCF (r =.077, $p = .429$).

Item twenty-four asked participants to agree or disagree with the statement *My social interactions tend to be mostly with students from the EXCEL program.* The results indicated a statistically significant relationship between sense of community and friendships focused on EXCEL (r =.500, $p < .01$). Approximately 25% of the variance in sense of community and friendships focused on EXCEL was shared, leaving 75% unexplained by the relationship. A positive moderately strong relationship existed revealing students who showed positive responses to friendships focused on EXCEL also showed positive responses on perceived sense of community.

Item twenty-five asked participants to agree or disagree with the statement *Sharing classes with other EXCEL students promotes studying together.* Because the majority of STEM learning communities are based on the curricular model (Courter & Johnson, 2007; Fentiman et al., 2001; Fromm, 2003; Morgan et al., 1995; Morgan & Kenimer, 2002; Pence et al., 2005; Richardson & Dantzler, 2002) it was expected that there would be a strong relationship between shared classes and the students' SOC. Further, support for the importance of students studying together to their perceived SOC could be found within the field of retention (Berger & Milem, 1999; Braxton & McClendon, 2002; Cuseo, 1991; Kuh, 2003; Laufgraben, 2005; Milem & Berger, 1997; Tinto, 1975; Tinto & Pusser, 2006; Welty, 1994; Zheng et al., 2002). The results indicated a statistically significant relationship between sense of community and sharing classes promoting studying together ($r = .716$, $p < .01$). Slightly over 51% of the variance in sense of community and sharing classes promoting studying together was shared, leaving only 49% unexplained by the relationship. A very strong positive relationship existed revealing students who showed positive responses to seeing shared classes promoting studying together also showed positive responses on perceived sense of community. The number of item responses, the percent of positive responses, and the correlation with the dependent variable for each ESOC item was provided in Table 8.

Research Question Two

Question two, *What underlying dimensions, if any, exist within the EXCEL experience and what are their relationships to a student's perceived sense of* *community?,* took the investigation a step further by looking into the relationship between multiple variables and sense of community.

Factor Analysis

A factor analysis was executed to isolate any composite of variables influencing SOC and to then use those factors to determine the amount of influence contributed to SOC by the total factor grouping and each factor. During a review of the literature and construction of the instrument, three factors emulating the EXCEL program co-curricular activities were expected to exist: the student support center, residence experience, and social interaction between peers and faculty. The first step of this investigation was to explore the factor structure underlying the responses from the sense of community data set. Items 1 through 25 of the ESOC instrument were to be used in a confirmatory factor analysis with an oblique rotation. Upon initial investigation into the descriptive statistics of the item responses (see Appendix K, Table 21) it was observed that no one standard deviation stood out as remarkably larger than the other variables and the standard deviations were smaller than the respective means for all items except one (OFFINCLUDE). Though the higher standard deviation could indicate a problem with the distribution of this variable, after consideration of the *not applicable* answer response allowed for this question it was viewed as allowable and remained in the analysis.

Table 8.

Survey Items from the ESOC and Their Correlations with the Dependent Variable

Survey item (variable code)	N	% of positive responses[a]	Correlation with dependent variable
Sharing classes with other EXCEL students promotes studying together (SHCLSSTDY)	108	87	.716**
My experience living in the EXCEL residence hall has increased my sense of belonging (RHSOBELNG)	64	41	.672**
Students in the EXCEL program care about each other (STCARE)	108	91	.559**
I feel valued as a person within EXCEL (VALUEDPER)	107	90	.557**
I am satisfied with the overall quality of instruction within the EXCEL program (SATQULINST)	108	90	.529**
I feel accepted as a part of the EXCEL community (ACCEPTD)	108	91	.520**
EXCEL Center programs foster positive relationships among the EXCEL participants (CTRPOSREL)	108	89	.517**
The EXCEL Center allows me to interact with students like me (CTRINTERST)	106	88	.509**
My social interactions tend to be mostly with students from the EXCEL program (SOCWXLST)	108	53	.500**
EXCEL faculty and students work together to promote my learning (FSWORKTO)	106	93	.471**
The EXCEL curriculum has made me interested in the study of math and science (CURINTSM)	105	75	.456**
The EXCEL Center provides services that enhance my academic success (CTRSERVSU)	106	93	.453**
My friends share my interests and values (FRNDSHRINT)	108	94	.438**
I live off-campus and feel included in the EXCEL community (OFFINCLUDE	36	21	.418*
EXCEL allows me to interact with people of different backgrounds (INTERACTDIV)	108	96	.412**
EXCEL graduate students are accessible to me when I seek their help (GAACCESS)	108	93	.368**

Survey item (variable code)	N	% of positive responses[a]	Correlation with dependent variable
I am satisfied with the range of extracurricular activities available at UCF (COCURUCF)	106	91	.360**
Faculty associated with this program care about students (FACCARE)	108	96	.344**
I am proud of this institution's history and heritage (PROUDUCF)	108	94	.304**
EXCEL faculty are accessible to me when I seek their help (FACACCES)	107	96	.300**
Living in the residence halls has raised my awareness of campus resources (RHAWARER)	69	54	.250*
The institution's traditions and celebrations play an important role in my life as a student (UCFTRADIT)	108	67	.248**
I am satisfied with the range of extracurricular activities available within EXCEL (COCURWXL)	108	67	.223*
I have felt lonely at UCF (FELTLONELY)	105	19	.083
I often felt under a lot of stress during my time at this institution (STRESS)	108	36	.077

[a] This column represents the total number of respondents who answered “strongly agree” or “agree” based on a 4-point scale of “strongly disagree” to “strongly agree”.
* $p < .05$
** $p < .01$

All 25 items were loaded into SPSS for the factor analysis. The maximum likelihood estimation procedure was used to extract the factors from the variable data. Initial scales were constructed removing factors that loaded at less than or equal to 0.3. The output was examined and communalities greater than 1.0 were discovered. It was important to deal with the variable causing the problem. By reviewing the communalities table (see Appendix K, Table 22) for each of the items, it was determined that the variable *socializing with EXCEL students* (SOCWXLST) was the problem. The item was removed and the factor analysis executed again. The output was examined and communalities greater than 1.0 were discovered. The communalities table was reviewed and it was determined that the variable *friends share interest and values* (FRNDSHRINT) was the problem. The item was removed and the factor analysis executed again. On the third attempt no items were found to have communalities greater than 1.0 so the data analysis could continue. Though initially expected to play an important role due to the support for peer interactions found in the literature (Astin, 1993; Bean, 2005; Berger & Milem, 1999; Braxton, 2003; Braxton & McClendon, 2002; Chickering & Reisser, 1993; Kuh, 2002; Milem and Berger, 1997; Pascarella and Terenzini, 2005; Tinto, 1975, 1993), the removal of these items was necessary as no more than 100% of a variable's variance can ever be explained and these variables were contradicting that assumption.

Using Kaiser's (1960) Rule, those factors with an eigenvalue of 1.0 or higher determined the extracted factors. The analysis produced six factors (see Table 9) which together were capable of explaining 68.78% of all the variable variances.

Table 9.

Eigen Values Produced from the ESOC Factor Analysis: Extracted Factors Only

Factor	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	7.902	34.538	34.538
2	2.511	10.916	45.275
3	1.625	7.063	52.338
4	1.515	6.589	58.927
5	1.166	5.071	63.998
6	1.100	4.781	68.779

A review of the initial factor loadings suggested that a proper solution was attainable through maximum likelihood, as it was capable of converging in 6 iterations. A review of the scree plot was used as a secondary method to confirm the extracted factors (see Figure 1). Proceeding with the analysis was further warranted as there was no warning of non-positive definite results.

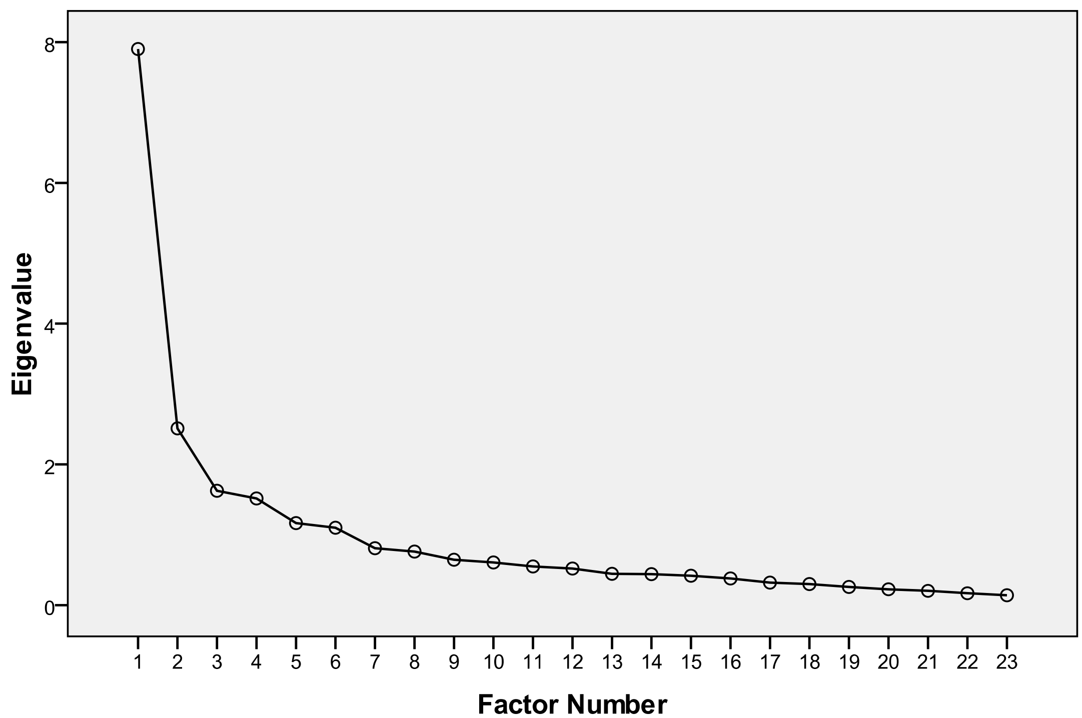

Figure 1. Scree plot representing the eigenvalues for the ESOC factor analysis

An oblique (Promax) rotation was chosen because it allowed for the assumption that some correlation may exist between the variables. Upon review of the factor correlation matrix (see Appendix K, Table 23), it was determined a relationship did exist between the factors with eleven of the twelve values exceeding .18 and the smallest value falling only slightly below that level. These results were large enough to justify retaining the results from the oblique rotation.

The structure coefficient matrix was then reviewed (see Table 10) to determine the grouping of the variables. The coefficients suggested that the way students viewed feeling valued as a person was very consistent with the way they responded to feeling accepted by the group, to students caring about one another, and to sharing classes encouraging studying together. These variables contributed most prominently to Factor 1. The remaining factors, determined by the magnitude of the coefficients, were identified in Table 10 by the shading, where shaded coefficients were the largest coefficients for each factor. The structure coefficients suggested that VALUEDPER was correlated .898 with Factor 1, therefore sharing roughly 81% of the variance of that factor. All the remaining coefficients were interpreted this way and the percentages of variance to the factor indicated in Table 10.

Reliability analysis. The next step of the factoring process was to run reliability analysis on each factor to reduce the scale to relevant items only, therefore increasing its reliability. The items making up a single factor were entered as a group for the reliability analysis. A Cronbach's Alpha was produced for each factor. Further analysis to improve the alpha was conducted on each factor, if warranted.

Items VALUEDPER, ACCEPTED, STCARE, and SHCLSSTDY were included in the analysis for Factor 1. Respondent ratings of Factor 1 obtained from the ESOC were judged to have a very good reliability for the students to whom it was given, with a reliability coefficient α = .818. A review of the corrected item-total correlations suggested that the variable SHCLSSTDY did not correlate with the corrected total very well. Removing the item meant the possibility of reducing the scale to only relevant items and further increasing the reliability coefficient reported in the output. The SHCLSSTDY item was removed and the reliability coefficient increased (α = .829). Respondent ratings of Factor 1 obtained from the ESOC were judged to have a very good reliability for the students to whom it was given, with a reliability coefficient α = .829.

Items FSWORKTO, SATQULINST, CURINSTSM, FACCARE, and STRESS were included in the analysis for Factor 2. Respondent ratings of Factor 2 obtained from the ESOC were judged to be moderately reliable for the students to whom it was given, with a reliability coefficient α = .790. A review of the corrected item-total correlations provided in the output suggested that the variable STRESS did not correlate with the corrected total very well. The STRESS item was removed and the reliability coefficient increased (α = .827). Further review of the corrected item-total correlations showed no items with a significantly higher alpha so the process was stopped. Respondent ratings of Factor 2 were judged to have a very good reliability for the students to whom it was given, with a reliability coefficient α = .827. This factor aligned with expectations from the review of literature that academic integration played an important role in students' SOC and success (Astin & Oseguera, 2005; Bean, 2005; Braxton, Bray, & Berger, 2000; Braxton, Milem, & Sullivan, 2000; Kuh, Kinzie, Schuh, et al., 2005; Pascarella & Terenzini, 2005; Seidman, 2005; Tinto, 2000a, 2007).

Table 10.

Structure Matrix from ESOC Factor Analysis

Variable	Factor					
	1	2	3	4	5	6
VALUEDPER	.898 (81)	.557	.439		.557	
ACCEPTED	.803 (65)	.563	.401		.625	.336
STCARE	.656 (43)	.390	.470		.338	
SHCLSSTDY	.623 (39)	.514	.555		.367	
FSWORKTO	.591	.860 (74)	.524		.582	.508
SATQULINST	.645	.828 (69)	.568	-.309	.558	.330
CURINTSM	.527	.717 (51)	.440		.372	
FACCARE	.421	.618 (38)	.527		.505	.448
STRESS		.442 (20)				.311
CTRSERVSU	.431	.623	.752 (57)		.378	
CTRPOSREL	.344	.323	.746 (56)			
GAACCESS	.378	.572	.708 (50)		.569	.539
CTRINTEREST	.551	.550	.604 (37)	-.311	.307	
RHAWARER				.881 (78)		
RHSOBELNG				.800 (64)		
OFFINCLUDE				-.759 (58)		
PROUDUCF	.435	.383			.761 (58)	
UCFTRADIT	.375				.638 (41)	
INTERACTDIV	.449	.605	.605		.615 (38)	.351
CORCURWXL		.445	.311		.613 (38)	.304
FACACCESS	.357	.690	.629		.476	.716 (51)
COCURUCF	.326	.587	.438		.443	.648 (42)
FELTLONELY						.350 (12)

Note. Numbers in parenthesis indicate the shared percent of the variance of that factor.

Items CTRSERVSU, CTRPOSREL, GAACCESS, and CTRINTERST were included in the analysis for Factor 3. Respondent ratings of Factor 3 obtained from the ESOC were judged to be moderately reliable for the students to whom it was given, with a reliability coefficient α = .772. A review of the corrected item-total correlations provided in the output revealed no items listing a higher alpha if the item was removed so the process was stopped assuming the highest correlation had been achieved.

Items RHAWARER, RHSOBELNG, and OFFINCLUDE were included in the analysis for Factor 4. A reliability analysis could not be conducted on this factor due to the negative nature of OFFINCLUDE. However, upon evaluation these three items all dealt with place of residence, had high factor loading at .881, .800, and -.759, and loaded with none of the other five factors. This factor alignment was no surprise as place of residence has been shown to be an influencing factor in retention (Astin, 1975, 1977, 2006; Astin & Oseguera, 2005; Boyer, 1987; Braxton, 2003; Chickering, 1974; Christie & Dinham, 1991; Pascarella, Terenzini, & Blimling, 1994; Pike, 1999; Pike, Schroeder, & Berry, 1997; Skahill, 2003; Upcraft, 1989a), with STEM populations (Gandhi, 2000; Hathaway, Sharp, & Davis, 2001; Hildreth & Brown, 2007; Johnson, Soldner, & Inkelas, 2006; Kampe et al., 2007), and on students' SOC (Berger, 1997; Jacobs & Archie, 2008; Lounsbury & DeNeui, 1995, 1996; Pretty, 1990; Wright, 2004).

Items PROUDUCF, UCFTRADIT, INTERACTDIV, and COCURWXL were included in the analysis of Factor 5. Respondent ratings of Factor 5 obtained from the ESOC were judged to be moderately reliable for the students to whom it was given, with a reliability coefficient $\alpha = .731$. A review of the corrected item-total correlations provided in the output revealed no items listing a higher alpha if the item was removed so the process was stopped assuming the highest correlation had been achieved.

Items FACACCESS, COCURUCF, and FELTLONELY were included in the analysis of Factor 6. Respondent ratings of Factor 6 obtained from the ESOC were judged to have poor reliability for the students to whom it was given, with a reliability coefficient α = .556. A review of the corrected item-total correlations provided in the output revealed the item FELTLONELY did not correlate with the corrected total very well. Removal of the item would leave Factor 6 with only two items and still only producing a low moderate reliability. Upon evaluation it was determined that Factors 5 and 6 were closely related and FACACCESS and COCURUCF had acceptable factor loadings with Factor 5. Because the item FELTLONELY loaded with no other factor and was to be removed from the factor with which it loaded, deletion of this item was deemed acceptable. Reliability analysis was conducted on the new Factor 5 including items PROUDUCF, UCFTRADIT, INTERACTDIV, FACACCESS, COCURUCF, and COCURWXL. Respondent ratings of the new Factor 5 obtained from the ESOC were judged to be moderately reliable for the students to whom it was given, with a reliability coefficient α = .764 – a higher reliability coefficient than reported for the original Factor 5. A review of the corrected item-total correlations provided in the output revealed no items listing a higher alpha if an item was removed so the process was stopped assuming the highest correlation had been achieved. The review of literature showed strong support for these items as contributing factors to student success and SOC (Attinasi, 1992; Beil et al., 1999; Kuh, 1994, 2002; Kuh et al., 2005; Kuh & Love, 2000; Laufgraben, 2005; Schroeder, 1994; Schroeder & Hurst, 1996; Shapiro & Levine, 1999; Tinto, 1993).

Naming the factors. Existing concepts identified in the review of literature were used to frame the extracted factors or constructs. Upon careful review and consideration of the factors, the items combined to create them, and the rich literature on which sense of community had been established, the five factors were named. The five factor solution using an oblique rotation resulted in the factor structure shown in Table 11: (1) open acceptance, (2) academic system interaction, (3) student academic support services, (4) residential experience, and (5) social system interaction.

Hierarchical Multiple Regression

To answer the second part of research question two, *what are their* [constructs] *relationships to a student's perceived sense of community,* multiple regression was used to determine the variance in the dependent variable (sense of community) accounted for by the set of independent variables (extracted factors or constructs). Item 26 of the ESOC represented sense of community and served as the dependent variable. In addition to the constructs identified through the factor analysis, place of residence and math section were used as independent variables and two other sets of items were used as control variables: background (gender, ethnicity, SAT mathematics score, high school GPA) and college academics (major, first semester GPA, year one cumulative GPA).

Before analysis could begin, each of the control variables and the independent variables of place of residence and math section had to be re-coded with dummy variables (see Appendix K, Table 25). Additionally, scores had to be calculated for each factor identified in the factor analysis. Using Pike's method (Pike, 2004), a continuous scale score was calculated for each respondent for the *open acceptance, academic system interaction, student academic support services, and social system interaction* factors.

Table 11.

ESOC Constructs and Composite Variables Identified through Factor Analysis

Construct (alpha)	Factor loading
Open acceptance (α = .829)	
I feel valued as a person within EXCEL	.898
I feel accepted as a part of the EXCEL community	.803
Students in the EXCEL program care about each other	.656
Academic system interaction (α = .827)	
EXCEL faculty and students work together to promote my learning	.860
I am satisfied with the overall quality of instruction within the EXCEL program	.828
The EXCEL curriculum has made me interested in the study of math and science	.717
Faculty associated with this program care about students	.618
Student academic support services (α = .772)	
The EXCEL Center provides services that enhance my academic success	.752
EXCEL Center programs foster positive relationships among the participants	.746
EXCEL graduate students are accessible to me when I seek their help	.708
The EXCEL Center allows me to interact with students like me	.604
Residential experience	
Living in the residence halls has raised my awareness of campus resources	.881
Experience living in the EXCEL res. hall has increased my sense of belonging	.800
I live off-campus and feel included in the EXCEL community	-.759
Social system interaction (α = .764)	
I am proud of this institution's history and heritage	.761
UCF's traditions and celebrations play an important role in my life as a student	.638
EXCEL allows me to interact with people of different backgrounds	.615
I am satisfied with the range of extracurricular activities available within EXCEL	.613
EXCEL faculty are accessible to me when I seek their help	.476
I am satisfied with the range of extracurricular activities available at UCF	.443

These scores were then used as inputs in the multiple regression. Due to the nature of the *residential experience* factor, Pike's method could not be used. There were three issues with the data that made Pike's method unacceptable: (a) the off-campus item loaded negatively, (2) the extensive use of the *not applicable* response to on-campus questions by non-residents and vice-versa, and (3) there were two questions representing on-campus residents and only one question representing off-campus residents. Using Pike's method, the not applicable responses would have counted the same as *strongly disagree* or *strongly agree* skewing results on both sides of the residence issue. Instead the researcher combined two of the composite variables, *My experience living in the EXCEL residence hall has increased my sense of belonging* and *I live off-campus and feel included in the EXCEL community*. Both questions address inclusion or belonging in the community based on place of residence. The response categories strongly agree and agree were combined as were the categories strongly disagree and disagree. The item responses were then dummy coded and the new residential experience factor used in the multiple regression.

Due to the high number of independent variables used in the regression it was determined the adjusted R^2 would be a better measure of the variance in the dependent variable. As the number of independent variables approaches the number of cases in the analysis, R^2 automatically approaches one. The adjusted R^2 accounts for the number of independent variables and provides a more conservative measure (Shavelson, 1996).

Model 1 incorporated the students' background characteristics which included gender, race, SAT math score, and high school GPA. A test for multi-collinearity, or a relationship between the independent variables, was conducted with tolerance (TOL) and variance inflation factors (VIF) for each of the independent variables being above .1 and below 10, respectively. Two variables, White and Hispanic, reflected lower TOL and higher VIF rates, but fell within the acceptable limits. No statistically significant relationship was found to exist between sense of community (SOC) and the background characteristics ($F_{10,97} = .986$, $p = .461$). Only 9% of the variance in SOC was accounted for by the background characteristics of gender, race, SAT math score, and high school GPA. Using the adjusted R^2 the adjusted proportion of variance between SOC and the background characteristics was less than 1%.

Model 2 incorporated the students' academic characteristics which included college of major, first semester GPA, and first year cumulative GPA while controlling for background characteristics. A test for multi-collinearity was conducted with tolerance (TOL) and variance inflation factors (VIF) for each of the independent variables being above .1 and below 10, respectively. However, the variables for first year cumulative GPA, reflected TOL values of .100, .106, and .124 and VIF rates above 9. Though falling within acceptable limits it was noted that first term GPA and first year cumulative GPA were both representing similar measures of the students' academic record. To decrease the amount of multi-collinearity the variables for first year cumulative GPA were removed from the regression equation. No statistically significant relationship was found to exist between SOC and student academic characteristics when controlling for background characteristics ($F_{5,92} = 1.313$, $p = .265$). Approximately 15% of the variance in SOC was accounted for by this model, adding the academic characteristics of college of major and first semester GPA. Using the adjusted R^2 the adjusted proportion of variance between SOC and model 2 was only 1.5%.

Model 3 incorporated the students' first semester math course while controlling for background and academic characteristics. A test for multi-collinearity was conducted with tolerance (TOL) and variance inflation factors (VIF) for each of the independent variables being above .1 and below 10, respectively. No statistically significant relationship was found to exist between SOC and the first semester math course when controlling for background and academic characteristics ($F_{1,91} = .028$, $p = .868$). The first semester math course added no difference in the variance in SOC and was removed from consideration in further models.

Model 4 incorporated the students' place of residence which included on-campus in the EXCEL learning community, on-campus not in the EXCEL learning community, and off-campus. A test for multi-collinearity was conducted with tolerance (TOL) and variance inflation factors (VIF) for each of the independent variables being above .1 and below 10, respectively. No statistically significant relationship was found to exist between SOC and place of residence when controlling for background and academic characteristics ($F_{5,90} = 1.766$, $p = .177$). Approximately 18.5% of the variance in SOC was accounted for by this model with the addition of place of residence. Using the adjusted R^2 the adjusted proportion of variance between SOC and model 4 was 3.1%.

Model 5 incorporated the five factors identified through the ESOC factor analysis process which included open acceptance, academic system interaction, student academic support services, social system interaction, and residential experience. A test for multi-collinearity was conducted with tolerance (TOL) and variance inflation factors (VIF) for each of the independent variables being above .1 and below 10, respectively. A statistically significant relationship was found to exist between SOC and the five factors when controlling for background, academics, and place of residence ($F_{5,85} = 15.12$, $p < .001$). Approximately 57% of the variance in SOC was accounted for by this model with the addition of the ESOC factors. Using the adjusted R^2 the adjusted proportion of variance between SOC and model 5 was 46%. Among the five factors two were found to be significant in their contribution, open acceptance ($p = .011$) and student academic support services ($p = .012$). The final regression equation based on model 5 was

SOC = .497 - .055(DUMGNDR) - .331(DMSATOL) - .112(DMSATIL) + .041(DMSATIH) - .09(DHSGPAH) - .167(DHSGPAM) + .346(DCWHITE) + .454(DCHISP) + .117(DCBLCK) + .234(DCASIAN) + .186(DCECS) + .072(DCOS) - .032(D1TRMAS) - .016(D1TRMST) + .206(D1TRMMS) + .172(DXLLC) + .273(DONCMPS) + .012(FOPENACPT) + .004(FACDMCINT) + .011(FACSPPRTS) + .270(FRESXPPOS) + .001(FSOCINT).

The standardized regression coefficients for each model were provided in Table 12. Removing the non-significant factors one at a time and again executing the linear regression resulted in the combination of factors with the highest adjusted R^2 (46.4%). In order of greatest contribution to the adjusted R^2 these were open acceptance (Δ in R^2 = .300), student academic support services (.06), and residential experience (.052).

Research Question Three

The third question, *What relationship, if any, exists between the first-year retention of EXCEL participants and their perceived sense of community?*, was determined by conducting a Chi-square (χ^2) Test of Independence. The expectation was to see a strong significant correlation similar to findings by Buck (2006), Harris (2007), Jacobs and Archie (2008), and Tucker (1999). Using data provided by the UCF Office of

Institutional Research (OIR), retention in a STEM major through the first year of college was determined for the EXCEL participants and used as the dependent variable. Responses of the EXCEL participants to item 26 of the ESOC instrument were used as the independent variable sense of community. In an attempt to ensure a large enough expected count for each block in the chi-square analysis, the SOC variable was re-coded into two categories. Strongly agree and agree were combined as were the categories strongly disagree and disagree. There was no statistically significant relationship between EXCEL students who were retained through the first-year and students' perception of sense of community ($\chi^2_1 = .081$, $p = .776$).

Part Two – Control Group Comparisons

Part two of the investigation, differences in the educational profile of EXCEL participants and non-participants, was addressed by research question four. There were subcomponents to this part of the investigation: differences in sense of community and differences in retention and being on-track in mathematics. The first component consisted of applying the ESOC factors to the University Sense of Community (USOC) responses and running independent t tests to determine differences in sense of community between the EXCEL participants and non-participants. The second component consisted of conducting a Chi-square (χ^2) analysis and a two-sample t test for both retention and math on-track. The final piece consisted of providing a set of descriptive statistics of the two groups, EXCEL participants and non-participants, and looking for differences in their first semester and cumulative first-year GPAs.

Table 12.

Standardized Regression Coefficients for EXCEL Regression Models

Independent variable	Model				
	1	2	3	4	5
Gender: male	-.054	-.108	-.110	-.108	-.036
Ethnicity: White	.310	.252	.251	.239	.233
Ethnicity: Hispanic	.373	.378	.376	.371	.250
Ethnicity: Black	.166	.139	.139	.167	.048
Ethnicity: Asian	.102	.132	.131	.143	.088
SAT: out range low	-.176	-.171	-.166	-.175	-.147
SAT: in range low	-.018	-.046	-.041	-.021	-.075
SAT: in range high	.146	.138	.139	.150	.028
High school GPA: high	-.024	.029	.027	.019	-.059
High school GPA: medium	-.094	-.102	-.105	-.099	-.112
College: CECS		.185	.180	.162	.111
College: COS		.083	.083	.052	.039
First term GPA: above strong		.061	.057	.027	-.020
First term GPA: strong		.123	.120	.077	-.011
First term GPA: moderately strong		.299	.296	.248	.128
Math course			.019	---	---
Residence: LC				.082	.117
Residence: on-campus				.196	.103
Open acceptance					.296*
Academic system interaction					.098
Student academic support services					.281*
Social system interaction					.024
Residential experience					.183
Adjusted R^2	*-.001*	*.015*	*.004*	*.031*	*.457*

* $p < .05$

Research Question Four

Subcomponent One – Sense of Community

It was expected that the research would show differences on the relationship of the factors for those participating in the STEM learning community supporting previous research that learning communities and other sub-communities increase SOC (Buck, 2006; Harris, 2007; Lounsbury & DeNeui, 1996; Wilson, Spring, & Hansen, 2008; Wright, 2004). The first component of question four, *What differences, if any, exist in the educational profile of first-year EXCEL participants and non-participants?,* used the UCF Sense of Community (USOC) questionnaire in the analysis. All items were rated on a scale of 1 to 4 with 4 equal to strongly agree and 1 equal to strongly disagree. In the absence of a neutral category, *not applicable,* was an answer option on questions 5, 6, 8, 9, 10, 12, and 16 and was identified as missing data on those questions so as to not skew the analysis results.

From the 824 students who were solicited as part of the control group, there were 104 responses to the survey. Six were found to be duplicates. These responses were removed prior to analysis. Of the 824 students surveyed, 98 of them (12% of the targeted population) responded to the questionnaire. Demographics on the responders versus the non-responders were provided in Table 13. Females were overrepresented in the responders. All categories, except for males (47% vs. 69%), had similar percentages between responders and non-responders to the USOC. Because the control group was chosen after the fall 2007 term began and all test scores were reported, the SAT math scores fell in the range of 550 to 650.

Table 13.

Demographics Comparison of USOC Responders and Non-responders

Gender/Race	Responders	Non-responders
Female	52 (53)[a]	228 (31)
Male	46 (47)	498 (69)
White	63 (64)	489 (67)
African American	5 (5)	42 (6)
Hispanic	20 (20)	111 (15)
Asian/Pacific Islander	8 (8)	64 (9)
Other[b]	2 (2)	20 (3)
SAT Range	550 – 650	550-650

[a] Percentages of the total responder and non-responder populations are calculated and shown in parenthesis.
[b] Represents groups without significant numbers for comparison: American Indian, Non-Resident Alien, and Not Specified.

The only difference between the ESOC and USOC instruments was the environmental context which the responders used to answer the sense of community questions. For this reason, the factors identified in the ESOC factor analysis were applied to the USOC responses to provide for an equal comparison of differences between the two groups. Using the same process outlined in the multiple regression section of question two, a continuous scale score was calculated for each USOC respondent for the open acceptance, academic system interaction, student academic support services, and social system interaction factors. The process of combining and recoding the residential experience factor was followed for the USOC responses as it was for the ESOC responses in the question two analysis. An independent t test was then executed on each factor to look for differences between the ESOC and USOC responders.

The independent t test for factor 1 found no significant difference in open acceptance between the EXCEL participants and non-participants (unequal variances t = -1.159, *df* = 193.4, *p* = .248). The EXCEL participant mean (M = 72.33, s = 17.71) was slightly higher than the non-participant mean (M = 69.87, s = 12.61).

The independent t test for factor 2 found no significant difference in academic system interaction between the EXCEL participants and non-participants (unequal variances t = -.297, *df* = 201.35, *p* = .767). The EXCEL participant mean (M = 74.17, s = 18.35) was slightly higher than the non-participant mean (M = 73.48, s = 14.82).

The independent t test for factor 3 found no significant difference in student academic support services between the EXCEL participants and non-participants (unequal variances t = -1.107, *df* = 202.3, *p* = .270). The EXCEL participant mean (M = 73.31, s = 19.17) was slightly higher than the non-participant mean (M = 70.6, s = 15.85).

The independent t test for factor 4 found no significant difference in positive residential experience between the EXCEL participants and non-participants (unequal variances t = 1.317, *df* = 203.43, *p* = .189). The EXCEL participant mean (M = .57, s = .497) was slightly lower than the non-participant mean (M = .66, s = .475).

The independent t test for factor 5 found no significant difference in social system interaction between the EXCEL participants and non-participants (t = 1.061, *df* = 204, *p* = .290). The EXCEL participant mean (M = 70.40, s = 14.7) was slightly lower than the non-participant mean (M = 72.47, s = 13.18).

Further investigation was conducted within each group to determine if any differences in sense of community (SOC) existed between specific segments of the population for either EXCEL participants or non-participants. This analysis was conducted using independent t test. The EXCEL participants revealed there was no statistically significant difference in SOC between the genders (t = -.561, *df* = 106, *p* = .576) or between ethnic groups. For the EXCEL non-participants, there was no statistically significant difference in SOC between the genders (t = -1.305, *df* = 96, *p* = .195). The only statistically significant difference in SOC between ethnic groups for non-participants occurred between Caucasian and African American students (t = 2.308, *df* = 66, $p < .05$). The Caucasian non-participant mean (M = 3.14, s = .503) was significantly higher than the African American non-participant mean (M = 2.60, s = .548). The statistics for each comparison for both the EXCEL participants and non-participants was provided in Table 14. Because a statistical difference was found for African American non-participants, further analysis was conducted using a two-tailed independent t-test to compare the African American EXCEL participants to the African American non-participants on SOC. A statistically significant difference was found to exist between the two groups with $t = 1.8396$ and t $\text{critical}_{.10}(14) = 1.761$.

Subcomponent Two - Retention

The second component of question four compared the EXCEL participants and non-participants on retention to the major through the first year and being on-track in mathematics for the student's declared major. All 174 EXCEL participants were used for this comparison. From the 824 students who served as part of the control group, there were only 240 who started in the same math courses, Pre-calculus and Calculus, as the EXCEL participants. To have equal comparisons, these 240 students were chosen as the control group for this portion of the investigation. The analysis consisted of conducting a Chi-square (χ^2) test of independence and a two-sample t test for both retention and math on-track. The final piece consisted of providing a set of descriptive statistics of the two groups, EXCEL participants and non-participants, and looking for differences in their first semester and cumulative first-year GPAs.

Table 14.

Summary of Differences in Sense of Community by Gender and Ethnicity within EXCEL Participant and Non-participant Groups

Variable	Participants			Non-participants		
	t	*df*	*p*	*t*	*df*	*p*
Gender	-.561	106	.576	-1.305	96	.195
White/Hispanic	-.893	84	.374	-.745	81	.459
White/African American	1.031	73	.306	2.308	66	.024*
White/Asian	.594	70	.554	.097	69	.923
Hispanic/African American	1.390	31	.174	1.884	23	.072
Hispanic/Asian	1.061	28	.298	.467	26	.644
African American/Asian	-.270	17	.790	2.120	11	.058

[a] Unequal variances t was used in interpretation of these variables
*$p < .05$

Retention. The first question addressed in this analysis was, is there a relationship between participation in EXCEL and retention within the major through the first year? The expectation, with support from the literature (Lenning & Ebbers, 1999; MacGregor et al., 2002; Pascarella & Terenzini, 1991), was that participation in the learning community would have a positive effect on retention. A Chi-square test of independence was executed. No statistically significant relationship was found to exist between participation in the EXCEL program and retention in the major through the first year (χ^2_1 = 2.631, *p* = .105). The second part of the investigation into retention was to determine if there was a difference in retention between the EXCEL participants and non-participants. A two-sample independent t test was executed. There was no significant difference in retention between the EXCEL participants and non-participants (unequal variances t = -1.779, *df* = 396.05, *p* = .076). The EXCEL participant mean (M = .18, s = .384) was slightly lower than the non-participant mean (M = .25, s = .434).

Further investigation was conducted within each group to determine if any differences in retention existed between specific segments of the population for either group, EXCEL participants or non-participants. This analysis was conducted using independent t test. The EXCEL participants revealed there was no statistically significant difference in retention between the genders (unequal variances t = -1.795, *df* = 81.22, *p* = .076) or between ethnic groups with the exception of statistically significant differences in retention that were found between African American EXCEL participants and Caucasian, Hispanic, Asian, and American Indian ethnic groups within EXCEL. For the EXCEL non-participants, there was no statistically significant difference in retention between the genders. The only statistically significant difference in retention between ethnic groups for non-participants occurred between Hispanic and Asian students. The Asian non-participant mean (M = .13, s = .344) was lower than the Hispanic non-participant mean (M = .34, s = .479). The statistics for each comparison for both the

EXCEL participants and non-participants was provided in Table 15. Because a statistical difference was found for Hispanic non-participants, further analysis was conducted using a two-tailed independent t-test to compare the Hispanic EXCEL participants to the Hispanic non-participants on retention. A statistically significant difference was found to exist between the two groups with $t = 5.285$ and t $\text{critical}_{.001}(60) = 3.551$.

Table 15.

Summary of Differences in Retention by Gender and Ethnicity within EXCEL Participant and Non-participant Groups

Variable	Participants			Non-participants		
	t	*df*	*p*	*t*	*df*	*p*
Gender	-1.795[a]	81.22	.076	1.114[a]	99.40	.268
White/Hispanic	.901	142	.369	-1.297[a]	63.48	.199
White/African American	5.066[a]	110	.000**	-1.466	160	.145
White/Asian	-1.114[a]	11.24	.289	1.342[a]	32.85	.189
White/American Indian	-1.096	111	.275	.417	165	.677
Hispanic/African American	2.101	32	.044*	-.751	48	.457
Hispanic/Asian	-1.490[a]	13	.160	2.066[a]	58.47	.043*
Hispanic/American Indian	-1.491	33	.145	1.122[a]	17.75	.277
African American/Asian	2.390[a]	10	.038*	1.574	6.07	.166
African American/American Indian	-3.500	14	.004*	1.371	15	.191
Asian/American Indian	-.337	11	.742	-.385	32	.703

[a] Unequal variances t was used in interpretation of these variables
*$p < .05$
**$p < .001$

Math on-track. The second question addressed in this analysis was, is there a relationship between participation in EXCEL and being on-track in mathematics for the specified major at the end of the first year? The expectation was, due to the tutoring provided through the EXCEL Center and the additional assistance from the math faculty, that students within the EXCEL program would be on-track in mathematics at a higher rate than the non-participants. This was not the first time research had suggested tutoring and faculty involvement may benefit STEM student success (Budny, LeBold, & Bjedov, 1998; Cole & Espinoza, 2008; NIE, 1984). A Chi-square test of independence was executed. A statistically significant relationship was found to exist between participation in the EXCEL program and being on-track in mathematics through the first year (χ^2_1 = 8.08, $p < .01$). The second part of the investigation into being on-track in mathematics was to determine if there was a significant difference in being on-track in mathematics between the EXCEL participants and non-participants. A two-sample independent t test was executed. There was a statistically significant difference in being on-track in mathematics between the EXCEL participants and non-participants (unequal variances t = -2.989, *df* = 382.42, $p < .01$). The EXCEL participant mean ($\underline{M}$ = .35, s = .479) was significantly lower than the non-participant mean ($\underline{M}$ = .50, s = .501).

Further investigation was conducted within each group to determine if any differences in being on-track in mathematics existed between specific segments of the population for either EXCEL participants or non-participants. This analysis was conducted using independent t test. The EXCEL participants revealed there was no statistically significant difference in being on track in mathematics between the genders (unequal variances t = .543, *df* = 172, *p* = .588) or between ethnic groups with the exception of statistically significant differences in being on-track in mathematics that were found between African American EXCEL participants and the Hispanic, Asian, and Caucasian ethnic groups within EXCEL. For the EXCEL non-participants, there was a statistically significant difference in retention between the genders (unequal variances t = 3.480, *df* = 96.83, *p* = .001). The female mean (M = .30, s = .464) was significantly lower than the male mean (M = .55, s = .498). Because a statistical difference was found for male non-participants, further analysis was conducted using a two-tailed independent t-test to compare the male EXCEL participants to the male non-participants on being on-track in mathematics. A statistically significant difference was found to exist between the two groups with $t = 3.309$ and t $\text{critical}_{.001}(\infty) = 3.291$. The only statistically significant difference in being on-track in mathematics between ethnic groups for non-participants occurred between Hispanic and Asian students. The Asian non-participant mean (M = .23, s = .470) was lower than the Hispanic non-participant mean (M = .57, s = .501). The statistics for each comparison for both the EXCEL participants and non-participants was provided in Table 16. Because a statistical difference was found for Hispanic non-participants, further analysis was conducted using a two-tailed independent t-test to compare the Hispanic EXCEL participants to the Hispanic non-participants on being on-track in mathematics. A statistically significant difference was found to exist between the two groups with $t = 1.792$ and t $\text{critical}_{.10}(60) = 1.671$.

Additional exploration. The educational profile of the EXCEL participants and non-participants was determined to encompass more than just the elements of retention and being on-track in mathematics. Further tests were conducted to determine additional differences, if any, between the two groups. Initially, the EXCEL participants and non-participants were compared for differences on the background demographics of gender, race, high school GPA, and SAT math score. Between the EXCEL participants and non-participants there were no statistically significant differences in gender, race, or high school GPA. However, there was a statistically significant difference in SAT scores between the two groups. Results from the independent t tests were provided in Table 17.

Table 16.

Summary of Differences in Being On-Track in Mathematics by Gender and Ethnicity within EXCEL Participant and Non-participant Groups

Variable	Participants			Non-participants		
	t	*df*	*p*	*t*	*df*	*p*
Gender	.543	172	.588	3.480[a]	96.83	.001***
White/Hispanic	.060	142	.953	-.947	69.19	.347
White/African American	3.506[a]	25.51	.002**	-.836[a]	5.37	.439
White/Asian	-.552	120	.582	1.725[a]	29.87	.095
White/American Indian	-.376	111	.708	-.948[a]	11.44	.363
Hispanic/African American	2.631[a]	41.83	.012*	-.450	48	.655
Hispanic/Asian	-.526	42	.602	2.131[a]	47.31	.038*
Hispanic/American Indian	-.377	33	.708	-.403	53	.688
African American/Asian	-2.216[a]	18.08	.044*	1.649	27	.111
African American/American Indian	-.849[a]	1.04	.547	.117	15	.908
Asian/American Indian	-.109	11	.915	-1.881	32	.069

[a] Unequal variances t was used in interpretation of these variables
*$p < .05$
**$p < .01$
***$p < .001$

A second investigation into differences between the two groups was initiated on the college variables of math class, residence, first-term GPA, and first-year cumulative GPA. Between the EXCEL participants and non-participants there was no statistically significant difference in first-term or first-year cumulative GPAs. However, there was a statistically significant difference in math course and residence between the two groups. Results from the independent t tests were provided in Table 18.

Table 17.

EXCEL Participant and Non-participant Background Characteristics Independent t Test Results

Variables				Participants		Non-participants	
	t	*df*	*p*	M	sd	M	sd
Gender	1.604[a]	353.33	.110	.30	.462	.23	.424
Race	-.276	412	.782	.67	1.118	.70	1.179
High school GPA	1.288[a]	388.62	.199	1.06	.810	.95	.876
SAT math	-2.069[a]	267.33	.040*	1.48	.788	1.62	.487

[a] Unequal variances t was used in interpretation of these variables

* $p < .05$

Table 18.

EXCEL Participant and Non-participant College Characteristics Independent t Test Results

Variables				Participants		Non-participants	
	t	*df*	*p*	M	sd	M	sd
Math class	11.24[a]	220.84	.000*	.51	.501	.05	.218
Residence	-3.76[a]	381.98	.000*	.35	.479	.53	.500
First-term GPA	.565	412	.572	3.0	.776	2.96	.853
First-year GPA	1.54[a]	405.19	.123	3.04	.587	2.95	.712

[a] Unequal variances t was used in interpretation of these variables

* $p < .05$

CHAPTER V
DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

The findings of this investigation were discussed in great detail throughout this chapter. To allow for a solid foundation from which readers could begin, an overview of the investigation was presented. Following the overview each question was addressed in depth. The discussion included results from the data analysis, interpretation, and connection to the literature. The chapter addressed limitations of the study and concluded with implications for the field and recommendations for future research.

Overview

The STEM pipeline continues to shrink. Evidence has been seen in the percentage of bachelor's degrees awarded in the STEM disciplines as compared to the overall number of degrees awarded. From a record high of 36% in the late 1960s the percentage of bachelor's degrees awarded has ebbed and flowed rebounding only slightly to 32% in 2006 (NSF, 2008). More disturbing was the fact that within this small percentage of degrees awarded in STEM disciplines, only half of those bachelor's degrees were awarded in the hard sciences (NSF, 2008). Called a "quiet crisis" (Jackson in Friedman, 2005, p. 252), the effects of the shrinking pool will only be felt "in fifteen to twenty years, when we discover we have a critical shortage of scientists and engineers capable of doing innovation…" (2005, p. 253). Important to this crisis, K-12 students are much less interested in science and engineering than in the past and are not as prepared to handle the college level work required to attain these degrees (ACT, 2006). The percentage of the ACT-tested students interested in engineering declined from eight to five percent over the last decade (ACT, 2006). Only 42% of those who enter college receive a bachelor's in their intended field of study (Adelman, 1998) and for STEM disciplines, other than the life sciences, these percentages were lower (Adelman). With a lower percentage of students showing interest and a lower percentage of those declaring STEM disciplines completing a degree in their intended field, the outlook for increased percentages of STEM students entering the workforce is not promising.

Institutions of higher education are being held more accountable by industry, government, and institutional leaders (Bailey, Bauman, & Lata, 1998; Berger & Lyon, 2005; Pappas Consulting Group, 2007; U.S. Department of Education, 2006). With the shrinking number of students interested in engineering and other STEM disciplines, institutions of higher education must attract and retain more students in these disciplines in order to increase the number of graduates. To do so, it is critical to devise strategies that are effective both in cost and outcomes to recruit, retain, and graduate more students in the STEM disciplines (Anderson-Rowland, 1997a, 1997b). Leaders have proposed that faculty and student services should create appropriate campus culture and programming to promote student success (Cheng, 2004b; Kuh, Kinzie, Schuh, et al., 2005; Mortenson, 2005; Noel, Levitz, & Saluri, 1985; Pascarella & Terenzini, 2005; Rendon, Jalomo, & Nora, 2000). To do so, the effect of the students' experiences on their success, or lack there-of, must be identified.

The overarching purpose of this research was to determine the relationship between a holistic learning community, EXCEL, and the retention of STEM students through the first-year of college. The EXCEL learning community consists of a myriad of activities: (a) advising activities, (b) faculty development activities, (c) educational activities, and (d) diversity activities (Georgiopoulos & Young, 2005). Not all activities were included in this study. The focus was only the out-of-class educational activities of the learning community which included the residential experience, the EXCEL Center, and the social integration components. The investigation specifically explored if a relationship existed between perceived sense of community of EXCEL participants and factors such as the EXCEL out-of-class educational activities, placement in a learning community, and retention in the STEM disciplines. The investigation sought to determine if there was any relationship to the retention of the participants in the STEM disciplines, and if a relationship existed, were there differences in retention rates of comparable students. Additionally, the investigation sought to identify whether underlying constructs of sense of community existed within the learning community and how powerful their influence was on student sense of community.

Discussion

There were four research questions which guided this investigation. Specifically, they included the following:

1. What relationship, if any, exists between the educational activities of the EXCEL program and the psychological sense of community perceived among the students participating in the EXCEL program?

2. What underlying dimensions, if any, exist within the EXCEL experience and what are the relationships to a student's perceived sense of community?

3. What relationship, if any, exists between the first-year retention of EXCEL participants and their perceived sense of community?

4. What differences, if any, exist in the educational profiles of first-year EXCEL participants and non-participants?

This section presented the findings of this investigation. The chapter then concluded with implications for students, faculty, administrators, and staff and recommendations for future research.

Research Question 1

What relationship, if any, exists between the educational activities of the EXCEL program and the psychological sense of community perceived among the students participating in the EXCEL program?

As expected, relationships were found to exist between the community, co-curricular items and students' perceived sense of community. The two items showing the strongest relationship to SOC were shared classes promoting students studying together and the EXCEL residence hall experience increasing the students' sense of belonging. These findings supported studies from the retention, STEM, and SOC literature. The results of the investigation directly supported Courter and Johnson's (2007) and Richardson and Dantzler's (2002) research that determined the most significant contributor to SOC of STEM FIGs was the relationship building between the students that occurred due to the shared class setting. In addition, these findings provided further support to the value of studying and the creation of study groups through co-enrollment (Kuh, 2003; Laufgraben, 2005) and to the idea that learning communities are environments that encourage students studying together (Zheng et al., 2002). These findings strengthen the ideas of fulfillment of needs (McMillan & Chavis, 1986) and purposeful communities (Carnegie Foundation, 1990) found within the conceptual framework proposed for this investigation. Shared classes continue to be important for encouraging out of class interaction and building a sense of community between students. The second strongly supported item influencing SOC was the EXCEL residence hall experience increasing the students' sense of belonging. This finding directly supported Wright's (2004) findings that living-learning community participants have high levels of SOC. Furthermore, the relationship of sense of belonging to SOC lends credence to the conceptual framework outlined in the review of literature, supporting McMillan and Chavis' (1986) element of membership and Schroeder's (1994) principle of involvement. Even though living in the residence halls increasing awareness of campus resources showed a very weak relationship to SOC, this variable continued to show support for the importance of residence halls identified in the literature.

By far the majority of the statistically significant co-curricular items exhibited only moderate support for the literature on student success and perceived SOC. Students caring about one another and feeling valued as a person both had moderately strong correlations. These findings were congruent with the conceptual framework of McMillan and Chavis (1986), aligning specifically with the elements of membership and shared emotional connection. Feeling accepted as part of the EXCEL community, like the previous two items, was supported by Boyer's idea of campus community through his principles of caring and open communities (Carnegie Foundation, 1990). These items directly supported the association with sense of community in the university setting and feelings of being cared about or treated in a caring way by the university reported by Cheng (2004b). Assisting students and helping them to see the campus as a caring and supportive environment were two of the elements Braxton and Mundy (2002) reported as aiding in the fight against student departure. These findings supported the idea of EXCEL moving students toward the ultimate goal of retention within the STEM major. Future research should pursue the relationship between student perceptions of being cared for and retention.

Another category of importance in the literature was the relationship or interaction between students, faculty, and the curriculum. The results found in this research, though all statistically significant, were mixed in their influence on SOC and the relationship with these variables. Strong relationships were found to exist between SOC and the students' perceived quality of instruction provided in the curriculum, faculty and students working together to promote learning, and the EXCEL curriculum increasing interest in the study of math and science. The relationship between faculty and students lends support to these early interactions which Pascarella, Terenzini, and Wolfle (1986) showed to have a positive influence on retention. The most surprising findings on the topic of faculty and student interaction were the low, but still statistically significant relationships found between SOC and accessibility of instructors, graduate students and faculty, and faculty caring for students. Program faculty caring about students and faculty being accessible exhibited weak though significant relationships to SOC. Perhaps students saw these two items as related to one another and increasing faculty accessibility in the future could lead to an increase in the perceived caring by faculty. The fact that graduate assistant accessibility played a greater role than faculty accessibility in the relationship to SOC was expected. Graduate assistants for the EXCEL program spent more time with the students as their role of tutor in the EXCEL Center. Students accessed the assistants by simply showing up to the lab for additional assistance. As faculty members may have been available only during office hours, class, or scheduled problem solving sessions, students would have had more difficulty locating the faculty and thus connecting with them on a more intimate level. The findings lend support to the literature that shows interaction with faculty to be a critical component to SOC and student success (Bean, 2005; Cuseo, 1991; Seidman, 2005; Tinto, 2000a, 2007). The significance of these relationships to SOC enhance McMillan and Chavis' (1986) elements of membership and influence, Boyer's (Carnegie Foundation, 1990) principles of open and caring communities, and Schroeder's (1994) principles of involvement and influence furthering the study of influences on SOC. Future researchers should explore the connection between faculty accessibility and perceived caring as they relate to one another and to a student's perceived SOC.

Moderate support for the literature was also found in the relationship of SOC to the EXCEL Center elements: (a) Center programs foster positive relationships among the participants, (b) Center allows interaction with students like themselves, and (c) Center provides services to enhance academic success. These findings were consistent with the literature on providing shared spaces (Kuh et al., 2005; Laufgraben, 2005; Smith et al., 2004; Zheng et al., 2002) to enhance student success by connecting and supporting students in their community (Braxton & Mundy, 2002). The findings regarding the Center provided moderate support for the work of Zeller (2005) which emphasized the importance of a place where students could go between classes to relax or study and provided a place to connect to campus. These findings were congruent with the framework established for this investigation supporting McMillan and Chavis' (1986) elements of membership, integration and fulfillment of needs, and shared emotional connection. Furthermore, the students showed a sense of investment, consistent with Schroeder's (1994) principles of learning communities, by connecting with one another through the Center provided as a part of the learning community.

Continuing with the idea of peer interactions found to exist in the EXCEL Center, there were other significant relationships found between peers and students' perceived SOC. The existence of a relationship between SOC and social interactions occurring mostly with students in the EXCEL program supported the literature on student type learning communities that suggested these communities allowed students to get to know others in their major and establish community earlier than the typical junior year when students enter the major (Lenning & Ebbers, 1999). Additionally, the significant relationship between SOC and friends sharing similar interests and values supported the work of Astin and Astin (1993) and Pascarella, Terenzini, and Blimling (1994) which indicated that students grouped with like-minded students were more likely to emulate the characteristics of that group and, ultimately, remain in the STEM disciplines. Not surprisingly, the relationship between SOC and EXCEL allowing interaction with people of different backgrounds was weak. The fact that this item was significant supported the idea of having a diverse group within the EXCEL program. However, though diversity of gender and ethnicity within the EXCEL cohort was an important factor in the selection process, the fact remains that all of the students were alike in their academic standing and interests in an area of study thus creating less of an environment for interaction with students of different academic backgrounds. These findings were consistent with McMillan and Chavis' and Schroeder's ideas of influence, integration, and investment as significant factors to establishing a sense of community.

One important aspect of the EXCEL learning community was to make sure students who lived off-campus felt included as part of the community as place of residence was only one component of the larger learning community. A relationship was found to exist with a student's SOC. Important to this investigation, these findings supported the idea that off-campus students can feel more connected through the use of learning communities (Boyer, 1987; Zeller, 2005).

Extracurricular items were found to have weak relationships to students' SOC. The fact that the relationship of extracurricular activities to SOC existed provided some support to Boyer (1987) and Kuh's (1995b) idea that students spend the majority of their time outside of class and it is what they do during this time that shapes their experiences.

The fact that UCF extracurricular activities had a stronger relationship to SOC than the EXCEL extracurricular activities was expected as more opportunities existed at UCF than within the EXCEL program. The fact these findings were significant, though weak, did lend support to the framework identified for this investigation. The extracurricular activities represented the principle of a celebrative community identified by Boyer (Carnegie Foundation, 1990), provided events creating a shared emotional connection identified by McMillan and Chavis (1986), and created identity as suggested by Schroeder (1994), all important elements to creating a SOC.

The final variables showing any significance in the relationship to SOC dealt with the heritage and traditions of the institution. A relationship to SOC within EXCEL was found to exist for both pride in the institution's heritage and history and UCF's traditions playing an important role in the life of a student. These findings supported Tinto's (1993) idea of commitment to the university through the integration of students into the social system, in this case through traditions and heritage of the institution. Like the institutional extracurricular activities described previously, these items were congruent with the principle of a celebrative community (Carnegie Foundation, 1990), shared emotional connections (McMillan and Chavis, 1986), and creating identity within a learning community (Schroeder, 1994).

Only two items were found to have no statistically significant relationship to student SOC. Contrary to the findings of Cheng (2004b), feeling lonely or under stress did not affect the SOC exhibited by students within the EXCEL program. Ideally, this would mean that the learning community was doing a good job in off-setting negative feelings typically associated with a low SOC as Astin (1985) suggested. However, this could be the result of non-response bias where students with a lower SOC and potentially suffering from greater levels of loneliness or stress did not respond to the survey. If the former was true, then the learning community could prove beneficial in meeting the goal of retaining more underrepresented minorities (URM) in STEM disciplines due to its use in combating students' inability to handle stress (Zhang & RiCharde, 1998), one of the major reasons for URM departure in the STEM disciplines.

As many factors play into a student's decision to persist so too are there a multitude of factors influencing a student's SOC. These multiple influences begin to account for the unexplained effects on student SOC. For these reasons the findings from question two of this research were important for the interaction effect to be understood.

Research Question 2

What underlying dimensions, if any, exist within the EXCEL experience and what are the relationships to a student's perceived sense of community?

Identifying the Factors

Five factors were identified through this investigation. Each of these aligned with the review of literature and together accounted for almost 69% of the variance in SOC. Open acceptance dominated the other factors. This result confirmed Cheng's (2004b) finding that an open and caring environment was critical to establishing a sense of community. Furthermore, this factor aligned precisely with Boyer's (Carnegie

Foundation, 1990) principles of an open and caring campus community. An unexpected result in the analysis for the open acceptance factor was the removal of the item shared classes encouraged studying together. This item had the highest individual relationship to SOC. Further investigation into the relationship of shared classes and SOC is warranted based on the limited analysis available in this investigation.

Academic system interaction was the second factor extracted. All items for this factor dealt with faculty student interaction and interaction with the curriculum. The third factor was student academic support services loading around the items associated with the EXCEL Center. The existence of this factor supported the literature on learning communities that promotes academic support centers as providing the settings and the opportunities necessary for students to work together and become more involved in their education. As Kuh et al. (2005) stated, "when students collaborate with others in solving problems or mastering difficult material, they acquire valuable skills that prepare them to deal with the messy, unscripted problems they will encounter daily during and after college" (p. 193).

Residential experience was the fourth factor and aligned perfectly with the three place of residence items. This was no surprise, however, this factor was problematic due to the construction of the items that composed it. This was primarily a result of allowing students to choose not applicable as an answer option.

Social system interaction was the fifth factor. Feeling lonely was removed from the factor which was contradictory to Cheng's (2004b) work, but was expected after the initial analysis showed no significant relationship between loneliness and SOC. The factor analysis ultimately met with the expectations of the literature. However, rather than only three factors emulating the EXCEL program co-curricular activities (the student support center, residence experience, and social interaction between peers and faculty), interaction divided into separate factors for social and academic interaction and the additional factor of open acceptance was extracted aligning with Cheng's (2004b) research.

Determining the Factor Influence

Consistent with the results reported by Cheng (2004b), the findings which included student background characteristics showed that there was no significance in the relationship between student SOC within the EXCEL program and gender, ethnicity, SAT score, or high school GPA. This finding was different from that of studies which looked specifically at the relationship between these items and retention. Both Tinto (1993) and Astin (1970, 1985) considered these and other background characteristics to have an influence on retention however, this same relationship did not seem to exist for SOC. This finding was supported by the definition of SOC which looked more at experiences within the community and with the community membership (McMillan & Chavis, 1986) than at pre-existing conditions. However, these factors could contribute to the creation of boundaries to keep others out of the group. More importantly, this result showed that the SOC within the learning community was similar regardless of a student's gender, race, or academic preparation. Future research could more deeply explore the reasons behind this relationship and in what circumstances gender and ethnicity may play a greater role.

Controlling for the background characteristics, the academic variables of college of major and first-term GPA were found to have no significant relationship to SOC. These findings were contradictory to those of Lounsbury and DeNeui (1995) who found that SOC was lower in engineering and life science majors than in mathematics and other science majors. This could be because there was not enough differentiation at the broader level of college as opposed to major. The differences between relationships of these variables to retention and SOC were once again evident. Desjardins, Kim, and Rzonca (2003) found first-year GPA to have a significant effect on retention for students in some STEM disciplines.

Place of residence was introduced as a variable looking at the EXCEL living-learning community, other on-campus living, and living off-campus. It was expected that place of residence would play a significant role in a student's SOC due to the extensive literature supporting the benefits of on-campus living. However, when controlling for the background and academic variables, there was no significant difference found between students due to place of residence. This was similar to previous STEM population findings by Ghandi (2000) who reported no difference in retention or academic performance between STEM women housed in a living-learning community (LLC) and those in traditional residence halls. More relevant to the SOC research, these findings contradicted Wright (2004), who found that LLC participants had higher Sense of

Community Index scores than did non-LLC participants. When delving further into the statistics from this investigation, it was surprising to find that the place of residence which came closest to having statistical significance was living on-campus, not the EXCEL LLC. One explanation may be that the traditional residence hall contained more programming than the LLC which was focused primarily on the STEM disciplines and grouping students for study. Future investigations should continue to explore this topic to determine the differences between the two environments and why one would induce a greater influence on SOC over the other. This research is important to furthering the knowledge on STEM students.

The factors. As expected, the incorporation of the factors produced a statistically significant result in the relationships to SOC and provided a powerful improvement in what accounted for the variances in SOC. All previous elements had accounted for only 3.1% of the variance in SOC. With the introduction of the five factors, the explained variance in SOC rose to 46%. One of the original inquiries in this investigation was to determine which of the co-curricular activities most heavily influenced the students' SOC. With the factors entered into the linear regression, this question could begin to be answered.

The EXCEL Center which shaped the student academic support services factor was found to have a statistically significant relationship to SOC, a finding which supported previous research by Brower (2007) who found students who received tutoring in an academic support center experienced an increased sense of belonging. These academic support centers as a part of a learning community tailor services to specific needs increasing students' commitment to the community (Laufgraben, 2005). This commitment was an important component of McMillan and Chavis' (1986) definition of SOC and more importantly Schroeder's (1994) principles of learning communities.

The EXCEL residence hall which was a part of the residential experience factor was found to have no statistically significant relationship to SOC, though it was close. The weakness of this factor was previously discussed. Perhaps a stronger, more robust measure of this item could have produced significant results. The results of this investigation were contradictory to previous findings by Berger (1997) and Wright (2004) who found that residence halls, and in the case of Wright LLC specifically, played a significant role in the composition and level of student SOC.

Social integration of students into the EXCEL community divided into two factors, academic system interaction and social system interaction, neither of which proved to be significant in their relationship to SOC. Being a primarily academically based program, the expectation was that academic interaction between students and faculty would play some role in increasing the students' SOC (Tinto, 2001). The findings of this investigation were similar to previous research conducted by Braxton, Sullivan, and Johnson (1997) and Braxton and Lien (2000) who found academic integration received limited empirical support for influencing student success, more specifically in those cases student departure. Perhaps it was too early in the students' careers for academic integration to influence SOC. Beil et al. (1999) found that connections to the academic systems became more important to students later in the college experience and the EXCEL students were only in their first year. Continued work on faculty development and increased interaction with the students could alter the factors influence on SOC. More research looking into the individual relationships with faculty and the curriculum developed by EXCEL will be necessary. As for the social system interaction factor, the findings were contrary to past research on the influence of social integration on student success, though the desired result of the majority of those investigations was retention (Attinasi, 1992; Beil et al., 1999; Kuh et al., 2005; Kuh & Love, 2000; Laufgraben, 2005; Schroeder, 1994; Schroeder & Hurst, 1996; Shapiro & Levine, 1999; Tinto, 1993). Specific to the study of SOC, these results were contradictory to findings by Cicognani et al. (2008) who found that SOC was positively correlated with social participation. The population could have something to do with the limitations of the social interaction factor. For example, these were students in difficult STEM disciplines who had limited time for social interaction. Perhaps targeting the group with more appealing social activities that do not hinder their academic studies could influence the results. Consideration must also be given to the two items removed in the initial review. Both items, socializing with EXCEL students and having friends with shared interest and values, would probably have fallen within the social system interaction factor. Further investigation into the two removed items as contributing variables will be necessary to determine if their inclusion would have changed the significance of the social interaction factor. Like Cicognani et al., this research would indicate that future investigations should explore the roles of different types of participatory activities and if any one activity influences SOC at a greater rate than the other.

The open acceptance factor, whose items had been expected to align with social integration, turned out to be the most significant influence on SOC. This finding supported one of Cheng's (2004b) primary factors of importance to developing SOC – "students' feelings of being cared about, treated in a caring way, valued as an individual, and accepted as a part of community" (p. 227).

Factor importance. This investigation was to determine which factors had the greatest influence on SOC. The best combination with the greatest impact was determined to be open acceptance, student academic support services, and residential experience. These findings were supported by the proposed theoretical framework of McMillan and Chavis (1986), Boyer (Carnegie Foundation, 1990) and Schroeder (1994). The EXCEL learning community had proven to be the creation of an open and caring environment (Carnegie Foundation) where students invest and become involved (Schroeder) in their community through fulfillment of needs and shared emotional connections (McMillan and Chavis). The research has shown that shared emotional connection and investment (open acceptance), fulfillment of needs and a purposeful environment (student academic support services), and membership and identity (residential experience) were all key components in developing a SOC within this STEM learning community.

Research Question 3

What relationship, if any, exists between the first-year retention of EXCEL participants and their perceived sense of community?

In reviewing the relationship between SOC and retention, the findings were contradictory to those of Buck (2006), Harris (2007), Jacobs and Archie (2008), and Tucker (1999). No relationship existed. Upon a deeper review of the data, this result was not so surprising. The 2007 EXCEL group that responded to the SOC survey was a very successful group of students with a 90% retention rate within the STEM disciplines, 19 points over the national average of 71% (C-IDEA, 2008), and over 83% agreeing that a SOC existed within EXCEL, which included the majority of those not retained. The retention rate of the non-responders was closer to 43%. The difference in retention rate suggests the possibility of differences in SOC as well and that the success rate of the responding group could very well be the cause of no difference in SOC and a result of non-response bias. Further investigation into SOC of groups with differing retention rates will be necessary to determine whether or not a relationship exists.

Research Question 4

What differences, if any, exist in the educational profiles of first-year EXCEL participants and non-participants?

The educational profile of students was a broad area to cover. To be consistent with the theme of the research, three areas were investigated to determine whether or not differences existed between the EXCEL participants and non-participants.

Sense of Community

No differences on the SOC factors were found between EXCEL participants and non-participants that responded to the questionnaire. One could assume that the high non-response rate for the non-participants played an important role in these results due to the fact that students acknowledging a sense of community on campus would have more investment (Schroeder, 1994), be influenced by the community (McMillan & Chavis, 1986; Schroeder), and be more likely to respond to the survey. For the factors open acceptance, academic system interaction, and student academic support services even though there were no significant differences found to exist, there were differences. EXCEL participants had a higher mean score than the non-participants. Supporting previous results from this investigation, the factors where EXCEL participants had the greatest difference from the non-participants were on the factors of open acceptance and student academic support services, both of which were found to have the most influential effects on EXCEL participant SOC. For the residential experience factor the EXCEL participant results could be interpreted to reflect a more positive residential experience in the learning community setting which supports previous research on SOC and residential experiences in learning communities (Berger, 1997; Jacobs & Archie, 2008; Johnson, Soldner, & Inkelas, 2006; Kampe et al., 2007; Lounsbury & DeNeui, 1995, 1996; Wright, 2004). More research on other types of learning communities with similar comparison groups would be necessary to determine differences in SOC factors within sub-communities.

Further investigation on SOC within each participant and non-participant group was conducted to determine if other differences existed. When looking at SOC for the African American EXCEL participants the level was found to be significantly higher than that of the African American non-participants. From this, one could deduce that the EXCEL learning community provided some benefit that increased the SOC for African American students ultimately assisting EXCEL in meeting the goal of encouraging more underrepresented minorities in STEM to graduation. This result was supported by previous findings from Best (2006) who identified SOC as significantly impacting success and retention of African American students at a predominantly white institution. She found that advantages provided for retention and the individual experiences for students were reasons to recommend participation in the LLC.

Retention

There was no statistically significant relationship found to exist between participation in EXCEL and retention in the STEM discipline through the first-year despite the fact all EXCEL participants were retained at a rate of 82% compared to 70% for the non-participants. Though the learning community was not able to show a statistically significant difference in retention for the STEM students, a difference most definitely existed. Further studies will need to be conducted on these groups to determine if significant differences arise in retention for subsequent years and in the ultimate graduation rate.

Investigation on retention within each participant and non-participant group was conducted to determine if other differences existed. Within the EXCEL learning community, there were statistically significant differences in retention found between races. African American students within the EXCEL learning community were retained at a higher rate. This result supported previous findings of Hotchkiss, Moore, and Pitts (2006) who reported only African American students participating in an LC at a predominantly white institution saw an increase in retention one year after enrollment. For EXCEL non-participants, only 50% of the African American students were retained through the first year, lending support to the EXCEL learning communities' positive effect on retention. The only statistically significant difference in retention for non-participants was found between Hispanic and Asian students with Asian students being retained at a significantly higher rate. Within the EXCEL learning community the retention rate for Hispanic students was greater than that of the Asian students and further testing confirmed that the learning community environment benefited Hispanic students. These findings were consistent with the work of Cole and Espinoza (2008) who suggested LLC as ways Latino STEM students could become more involved with peers and faculty which was known to increase retention rates within this population. As has been called for in previous research, continued investigation into the effect of learning communities on different populations is important. Even those learning communities without targeted programs for underrepresented minorities can cause an impact.

Math On-Track

Second in importance only to retention in the STEM discipline is being on-track in mathematics for one's particular STEM discipline. EXCEL participants were on-track at a significantly higher rate than those in the similar control group suggesting that the EXCEL learning community assisted students not only in being retained in their STEM discipline, but also in advancing them toward graduation in their expected discipline at a quicker pace. Stumbling on math courses slows the progression of students in STEM disciplines and can often discourage them from continuation in the discipline if they fall too far behind (Seymour and Hewitt, 1997; Suresh, 2007). Because almost 70% of the growth in math and science skills have been shown to occur in the first two years (Pascarella & Terenzini, 2005) being on-track in mathematics for the discipline becomes even more important.

Men benefited from participation in the EXCEL learning community. The learning community provided a better environment for keeping male students on-track in mathematics in the STEM disciplines. Though males, particularly white males, have always been the dominating force in the STEM disciplines this trend and the population growth has shifted (NSTC, 2000). Creating interest and retaining males of all races in the STEM disciplines is more important than ever. In terms of ethnicity, the news was just as good for the African American EXCEL participants regarding being on-track in mathematics as it was for retention. African American EXCEL participants were on-track at a higher rate than all other ethnicities with the exception of American Indian. Again, the EXCEL learning community provided an environment where African American students could excel in their STEM discipline. For the non-participants, the only difference in being on-track in mathematics was found between Hispanic and Asian students with Asian students being on-track at a significantly higher rate. Within the EXCEL learning community the rate for Hispanic students being on-track was greater than that of the Asian students indicating that the learning community environment benefited Hispanic students. The findings supported this assumption. Again, these findings were consistent with literature from Kuh et al. (2006) which encouraged engagement as a benefit to Hispanic students.

Additional Exploration

The only background characteristic that resulted with a statistically significant difference between the EXCEL participants and non-participants was the SAT mathematics scores. This was no surprise as the EXCEL participant group had both lower and higher, predominantly lower, SAT mathematics scores based on selection and retesting after selection into the program while the non-participants were chosen after the beginning of the fall 2007 term when SAT scores were finalized. This result does open another area for future investigation into whether or not the lower SAT scoring EXCEL participants were more successful in retention and being on-track in mathematics due to the benefits of the learning community.

There was no significant difference between the two groups in first-term or first-year cumulative GPAs. However, for both first-term and first-year cumulative GPA, the

EXCEL participants recorded a higher average GPA, 3.0 versus 2.96 and 3.04 versus 2.95, respectively. Good news for both groups came in the fact success through good grades during the first year enhances the academic integration of students and is important to their future academic success and degree completion (Pascarella & Terenzini, 2005). Statistically significant differences were found to exist between EXCEL participants and non-participants in both the math class and residence variables. Basically these differences indicated that more EXCEL participants than non-participants started in pre-calculus rather than calculus making previous positive results on retention and on being on-track in mathematics even stronger. Students beginning in lower levels of math often struggle to succeed in the STEM disciplines while math ready students are more likely to persist to the second year (ACT, 2008b). As for the residence variable, the results indicated that more of the EXCEL participants lived on-campus, another characteristic supported by the literature which could have played into their success (Astin & Oseguera, 2005; Christie & Dinham, 1991; Johnson, Soldner, & Inkelas, 2006; Kampe et al., 2007; Pike, 1999; Pike, Schroeder, & Berry, 1997).

Significant Findings of the Study

McMillan and Chavis' (1986) sense of community theory was a strong framework for the study of sense of community (SOC) within the EXCEL learning community. The elements of membership, influence, integration and fulfillment of needs, and shared emotional connections along with principles set forth by Boyer (Carnegie Foundation, 1990) and Schroeder (1994) were evident in the findings from the investigation.

One important contribution of this investigation was the identification of influences on SOC. The findings of the correlation analysis showed that 23 of the 25 elements from the ESOC survey were statistically significant in their relationship to SOC for the EXCEL participants. Two activities stood out above all others in their contribution to SOC. The most significant contribution to SOC came from students sharing classes which promoted studying together. This is consistent with findings on other student success factors and current practice within the STEM field which utilizes curricular learning communities as one of its strongest interventions (Courter & Johnson, 2007; Fentiman et al., 2001; Fromm, 2003; Morgan et al., 1995; Morgan & Kenimer, 2002; Pence et al., 2005; Richardson & Dantzler, 2002). The second activity with a strong contribution to SOC was the student's experience living in the EXCEL residence hall and the potential increase this provided to their sense of belonging. Residential learning communities have boasted continued success in contributions to retention, SOC, and other student success factors throughout the literature. This finding fills a void in the current STEM literature on assessment of residential components as part of a STEM learning community. These significant findings add to the literature by identifying specific factors that contribute most to student SOC (Harris, 2007; Jacobs & Archie, 2008; Pretty, 1990; Wright, 2004). An additional significant contribution of this study was the support for the adapted ESOC instrument as a good measure for SOC elements.

Specifically, this investigation identified which factors of a learning community were most influential on SOC. The primary objective of this study was to determine if underlying constructs or factors existed and, more importantly, if so which ones contributed the most to student SOC within the STEM learning community. The factors (1) open acceptance, (2) academic system interaction, (3) student academic support services, (4) residential experience, and (5) social system interaction were identified and aligned with previous research discussed in the review of literature. This investigation found the factors open acceptance and student academic support services to be statistically significant in their contribution. No statistically significant relationship was found for residential experience, though the factor was a strong contributor. These findings were substantiated by previous research of Cheng (2004b) and others (Boyer, 1987; Brannan & Wankat, 2005; Braxton & Mundy, 2002; Kuh et al., 2005; Laufgraben, 2005; Smith et al., 2004; Zheng et al., 2002). The greatest contributing factor to SOC within the EXCEL learning community was open acceptance which included feeling valued as a person, feeling accepted as part of the EXCEL community, and believing students in the EXCEL program cared for one another. Inconsistent with the retention literature and Cheng's (2004b) previous finding was the lack of contribution to SOC by the social system interaction factor. This could be attributed to the STEM population who may have been more focused on academic factors or were considered to be more introverted personality types (Felder & Brent, 2005). This could also have been credited to the structure of the EXCEL program which was more academic in nature.

Upon investigation into the factors, one additional element of interest developed. The controlling variables were found, through the regression modeling, to have no significant relationship to SOC. Contrary to literature of the effects of background and academic characteristics on retention (Astin, 2006; Astin and Oseguera, 2005; Glynn, Sauer, & Miller, 2003; Kuh, Kinzie, Schuh, et al., 2005; Pascarella and Terenzini, 2005; Terenzini and Reason, 2005), these findings seem to show that SOC may react to these variables differently, or not at all. Additional findings from this research, confirmed the result for this group. However, the lack of significant differences could be specific to the EXCEL group who were extraordinary in their retention to the discipline and stronger feelings of SOC.

The importance of a presence of SOC in the EXCEL program was the potential affect on retention within the STEM disciplines. A disappointing result of the investigation was the finding that no significant relationship existed between retention and SOC for the EXCEL participants responding to the ESOC. However, further investigation into the data identified high levels of retention, significantly over the national average, and high levels of SOC among the ESOC responders. These unusually high levels on both data points could be attributed to non-response bias. Subjectively, one could conclude that the high retention was a by-product of the increased SOC, but without the statistical support this would be a weak argument.

This investigation contributed to retention research and the study of STEM by determining differences between the EXCEL participants and non-participants and seeing what advantages existed as a member of the EXCEL learning community. The strongest and most significant finding was that students participating in the EXCEL learning community were on-track in mathematics at a higher rate than their non-learning community counterparts. Second only to being retained in the STEM discipline, it is imperative that students progress in the courses critical to success in their major. This finding supported the success of the EXCEL program in meeting the goal of advancing students to graduation. Though not statistically significant, the results on SOC and retention in the EXCEL learning community were positive. In both instances, the EXCEL participants experienced higher levels of retention and perceived a greater SOC within their environment. This speaks to the potential of more significant findings as the EXCEL students progress into subsequent years of their academic careers. Findings, supporting the work of Best (2006) and Cole and Espinoza (2008), suggested that the EXCEL learning community environment was more beneficial for African American students in both retention and being on-track in mathematics than for other ethnic groups who participated. Additionally, there were benefits in SOC for African American students who participated in the EXCEL learning community over those who did not which would be consistent with the findings within EXCEL. Another major contribution of this investigation was the identification that male students participating in the EXCEL learning community were on-track in mathematics at a higher rate over those who did not participate. Additionally, significant positive differences were found for Hispanic students participating in EXCEL. These results suggest the learning community environment provided an element that aids male, Hispanic, and African American students in being successful during the first-year of a STEM discipline.

Limitations of the Study

Several factors that impacted the study are acknowledged. Limitations include, but may not be limited to the following list.

1. The dependent variable for this study, sense of community (SOC), was based on a single question student perception of the community not a total scale score. There were other measures (e.g. Sense of Community Index, Campus Community Scale) that provided sense of community scores, but did not allow for the determination of scale scores on the independent variables examined in this investigation. A secondary instrument providing a scaled score, which is a stronger measure for the statistics used in this investigation, could have been used to measure SOC or used to correlate scores between the two instruments.
2. The EXCEL program used in this study was unique to UCF. UCF used selective FTIC admission policies and had a high rate of student retention. The EXCEL program was unique in the holistic combination of activities provided to the participants. Therefore the results may only be useful when generalized to similar institutions with like programs.
3. Due to the unique nature of the EXCEL program, exact replication of this research would be difficult. However, pieces of the investigation could be replicated using the separate components of the program: residence hall, academic support center, programmed social activities.

4. The EXCEL program has been active since 2006. Due to on-going evaluation and changes in the structure of the program, only one group within the program, the fall 2007 cohort and control, was used for this investigation.
5. Not all aspects of the learning community were investigated in this study. Other EXCEL program activities could have contributed to or detracted from the overall success of the students. Extensive investigation was conducted on the curricular portion of the learning community by the mathematics and engineering faculty, but no investigation was conducted on the out-of-class activities nor into the perception of community within the group. For this research, the interest was in determining the contribution of the out-of-class educational activities on the students' psychological sense of community and ultimate retention in the program.
6. Due to the scheduling necessary to conduct the survey and receive timely results on SOC within the program participants first year, a pilot of the adapted instrument was not possible. Additional changes would have been warranted if a pilot study had been an option. One example was the weakness of the residential experience questions. The off-campus question loaded negatively in the factor analysis primarily due to the not applicable answer option. The residential experience questions could have been moved in to one question or a *skip* option offered in place of not applicable. These minor changes could have changed the effects of the residential experience.

7. The Sense of Community questionnaire was administered during the spring semester of 2008. Students who started in fall 2007 but were not enrolled in spring 2008 were not equally represented in the study. Several attempts were made to contact these students for participation in the study.
8. A self-report approach was used to collect perception data on sense of community. As with any self-report approach, participants may have provided unreliable answers due to a desire to answer as they believe the researcher would want them to answer. Additionally, non-response bias could be an issue that affected the results and requires additional investigation.
9. This investigation dealt with only the effects of SOC, retention, and being on-track in mathematics during or directly after the first-year. Results may differ as students move through the EXCEL program and into the junior and senior year. For example, students do not always change majors in a timely fashion. Retention and on-track in mathematics results may change as the student progresses to future years.
10. For the number of variables considered in the linear regression, a larger sample size would have been preferred. However, to account for the number of variables and any existing relationships within the variables, the adjusted R^2 was used for interpretation of the results.

Implications for Practice and Policy

Though specific to the EXCEL program and students within the STEM disciplines, the results of this research may be considered by any student attending college, any practitioner looking for ways to improve the academic environment or success of students, or any faculty member searching for the best way to assist students in the learning process.

For practitioners who desire to enhance the learning environment and, in turn, the success of students, the identification of elements influencing a student's sense of community is immense. These co-curricular activities provide practitioners with a starting point from which to create useful interventions to increase a student's SOC and thus student success (McMillan & Chavis, 1986). Knowing that sharing classes encourages students to work together outside of class on academic issues and increases SOC within their environment, faculty members can work with one another to establish coherent, team taught curricular learning communities from which students and faculty can benefit from the collaboration. Specifically, it is recommended that academic and student service professionals work together to develop communities where students are treated as individuals and feel cared for not only by their peers, but also by their advisors and faculty members. Practitioners and faculty need to create open environments, respectful of all people where everyone feels accepted. In addition to creating these environments, interventions need to include student support services, especially for those programs centered around academics. Within these centers, faculty and staff must foster positive relationships, allow interaction with other students, and make themselves and other resources available to students. It is important that practitioners take advantage of sources which have already proven to add to the success of students, the residence hall environment. More should be done in the residence hall to connect students to their academics and with other students in similar programs, but the social side of this intervention cannot be lost in the process. Simply placing *similar* students together in a residence hall does not immediately make them more successful. Thought must go into the programming of any residential environment, but especially those within a learning community and those with a desire to increase the students' perceived sense of community. For STEM professionals creating caring environments within the learning community experience is vital to the retention and success of students from underrepresented backgrounds, both by gender and race. Knowing that learning communities aid underrepresented minority students and males struggling with success in the STEM disciplines provides ammunition to upper level administration for implementation support. Blocking key classes like science and mathematics in majors' courses is an essential component to encouraging student interaction around academics outside of class. To incorporate the social aspect which plays such an important role in student retention, STEM faculty and practitioners need to broaden the set of activities available to students within their programs. In the tough budget times at hand, program coordinators should take advantage of university resources by identifying and using activities planned throughout the institution. However, academics cannot be pushed aside. To encourage students in their academics and to develop a stronger SOC within the academic environment, faculty members need to be accessible which is perceived by students as caring about them as individuals. STEM faculty and staff must work together to create a climate of caring within academia – no one group can do it alone.

For students and parents the implications of this investigation are vast. These findings empower constituents to make educated decisions that can completely change the college experience. Becoming a part of the college community and establishing a SOC within that environment are important to a student's fit with the institution and subsequent retention. Knowing which factors play most significantly into SOC can assist students and parents in selecting programs within which to participate, to be able to compare the offerings of different programs, and to determine which, if any, would be the best fit for the individual student. For STEM students, this investigation shows that participation in a STEM learning community can assist those students beginning in a lower level of math, Pre-calculus, be as successful as students beginning in the standard Calculus. From this investigation the learning community environment has been shown to provide additional benefits for students of color and males on different measures of success including retention and being on-track in mathematics. Specifically, students participating in the EXCEL learning community were on-track in mathematics at a higher rate than non-participants. For students this means less wasted time repeating classes, fewer frustrations with perceived barrier courses, and progress to graduation with completion in a more traditional four-year time frame. For parents this has financial implications. More institutions are charging higher fees for second and third-attempts on classes and many others are implementing excess hour fees for classes taken over-and-above the necessary limit to complete the degree. STEM students being on-track in mathematics means a timely completion of their degree and fewer of these unexpected fees. For STEM students being on-track in mathematics is second in importance only to being retained within the discipline. Though not showing a significant difference, students participating in the STEM learning community had a higher rate of retention through the first year. This could be credited to the more positive, intimate experience students are exposed to in the learning community. Armed with these findings, students and parents are equipped to make better decisions about the college experience they desire to have.

For institutions interested in establishing policy to increase student success in STEM during the first-year this investigation provides support for mandating a number of already proven strategies. One suggestion would be requiring on-campus housing in the first-year. Within the residence halls affinity groups could be formed to aid the students in identifying others with common interests. If founded on academic interests, this would be another way to extend the classroom into the living space and encourage study groups. Unfortunately budget and physical facility constraints may make this impossible at many institutions. Blocked math and science courses, an already successful strategy in STEM, should be implemented for all incoming STEM freshmen creating a cohort-type of program in the first year. This investigation was able to show this strategy encouraged students studying together. Additionally, it breaks larger institutions into smaller curricular learning communities within which students can connect. With the success of academic support services in influencing SOC, curriculum coordinators in STEM disciplines should mandate tutoring or recitation sessions for all math and sciences course. Since many students are unwilling to seek out assistance on their own requiring such a component may increase the success of those unwilling to take extra steps to help themselves. The logistics of blocked classes and recitation sessions for the masses may be the greatest implementation barrier.

Implications for Future Research

The findings of this investigation expand the existing body of research on student sense of community and the field of study encompassing science, technology, engineering, and mathematics students, while adding to the vast repository of literature on retention. However, because we are dealing with unique institutions and students as our subjects of study, investigation on sense of community and retention will continue to find new and sometimes conflicting results. With that understood, the investigation into the interaction between sense of community and retention must continue. Braxton, Hirschy, and McClendon’s (2004) idea of communal potential was a critical addition to Tinto’s (1993) social integration component of the interactionalist model of college student departure. The idea that students believe a subgroup of students exists that are like them with shared values, beliefs, and goals is the underlying premise of student type learning communities. Important to this investigation, was determining the success of the learning community through the measurement of student sense of community (SOC) and identifying the co-curricular aspects of the learning community with the most influence on SOC. Future components of this research include:

1. a qualitative follow-up on the influential factors on student SOC at least one year out from the survey to determine changes in SOC, reflection on influences in the first year, or other influences realized since the original questionnaire,
2. investigation into retention and progression to graduation two years out,
3. comparison of SOC at the end of the EXCEL experience to these results collected half-way through the program, and
4. whether being on-track in mathematics at the end of the first year translates into higher graduation rates.

Too much of the variance in SOC was left unexplained by this research and, for this reason, it is important that future studies continue the investigation into the factors influencing SOC. Researchers may need to look at factors associated with personality as suggested by DeNeui (2003) and Lounsbury et al. (2003) or perhaps the culture of college programs (Micceri & Borman, 2006). The list of factors could be endless. Future researchers must replicate the research on SOC comparing different sub-communities of students to determine if the factors affect those students differently or if other factors exist. From the findings of this investigation, it is important that more research go into the influences on SOC that may be different between the genders and ethnic groups and whether these differences exist in environments other than learning communities. A final area needing deeper investigation are the influences exerted by STEM residential learning communities. Though this investigation began to shed light on the previously limited topic, mixed results indicate more research is needed before conclusions can be drawn on their effectiveness for enhancing student SOC.

The strong reliability of the instrument data confirmed previous results from Cheng (2004b) that the questionnaire used in this research is an effective tool for evaluation of SOC and the influencing campus community factors. Future research utilizing the tool should be conducted to further test this finding.

Because of the non-significant findings on the relationship between retention and student SOC, further investigation needs to be done. Does this relationship exist? Does one influence the other? Lastly, an area of limited study is being on-track in mathematics. In addition to the study of retention in the STEM disciplines, further research looking into the relationship between participation in a learning community and being on-track in mathematics at the end of the first year, as well as whether a relationship exists between this and higher graduation rates in the STEM disciplines or between being on-track and years to graduation in a STEM discipline, should be completed.

Conclusion

This investigation has shown that SOC is impacted by a multitude of factors found within the environments of college campuses and has further explored their influence. The most influential of these factors for the STEM population at hand are open acceptance, student academic support services, and residential experience. Specifically, students need to feel valued, accepted, and cared for; they need to be provided out-of-class services to enhance their academic success and to allow them to have positive interactions with peers, faculty, and staff; and they need to be provided with residential environments that meet both their social and academic needs. The investigation also provided support for learning communities as a positive intervention for STEM populations, specifically for some underrepresented populations. Most importantly there were significant differences for African American students participating in the STEM learning community on the measures of retention and being on-track in mathematics. Additional data suggested higher levels of SOC for African American students who participated in the learning community, higher levels of being on-track in mathematics for male students, and differences in retention and being on-track for Hispanic students participating in a STEM learning community.

APPENDIX A

EXCEL MANAGEMENT COMMITTEES

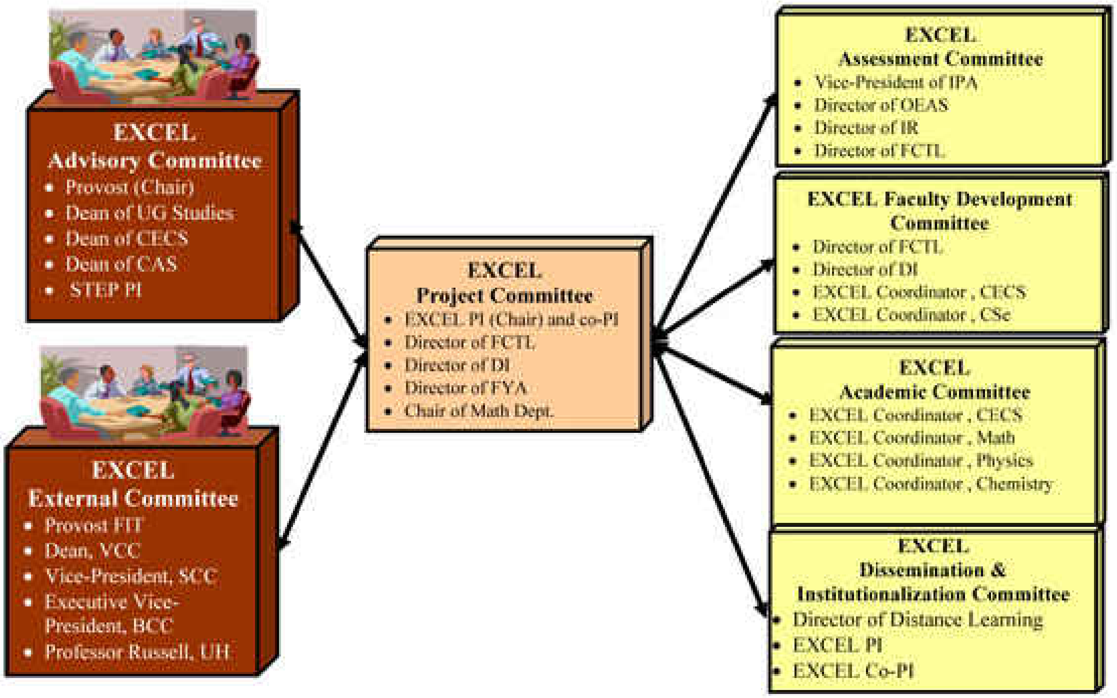

Figure 2. EXCEL management plan: Identifies membership of and the committees critical to the maintenance of the EXCEL program.

APPENDIX B

PERMISSION FOR INSTRUMENT

Melissa Falls - Re: Follow-up: Sense of Community survey

From: Melissa Falls
Subject: Re: Follow-up: Sense of Community survey

>>> "David Cheng" <dxc1@columbia.edu> 1/28/2008 3:56 PM >>>
Dear Melissa,

Thank you for your interest in my study. As I stated in the paper, we created a section in our annual enrolled student survey to deal with issues related to students' sense of community. You are more than welcome to use the items cited in the study, though the rest of survey is very institution-specific and thus not applicable to your institution. Also, feel free to modify the items to make them fit your institutional environment better.

Best of luck on your study.

David

From: Melissa Falls [mailto:mfalls@mail.ucf.edu]
Sent: Saturday, January 26, 2008 10:53 AM
To: dxc1@columbia.edu
Subject: Request to use Sense of Community survey

Dr. Cheng

I hope this message finds your semester going well. I am writing to request permission to use the annual enrolled student survey you reported on in your NASPA Journal article, "Students' Sense of Campus Community: What it Means, and What to do About it" (Winter 2004).

I am the Director of Academic Affairs for the College of Engineering & Computer Science at the University of Central Florida and work closely with our National Science Foundation sponsored STEP grant project. You can learn more about the program at our website www.excel.ucf.edu. Through the program, EXCEL, we have worked to establish a learning community through the use of residential block housing, hand-picked STEM faculty, a math cohort from pre-calc to differential equations, and a tutoring center which offers problem solving, individual tutoring, and professional advising. We are interested in assessing the students' perceptions concerning the community by looking at the relationship between the program factors and the student's sense of community. Your institution's instrument would assist in this process. We would like to administer the survey later this spring to our two cohorts - First-Year and Second-Year students.

I appreciate your consideration of this request. I do not want to consume too much of your time with intimate details - I am passionate about this project and could go on forever. Please feel free to contact me for more details or if you have any questions.

Regards,

Melissa Dagley-Falls
Director, Academic Affairs
College of Engineering and Computer Science
www.cecs.ucf.edu/acadaffairs/

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"UCF Stands for Opportunity"

APPENDIX C

EXCEL SENSE OF COMMUNITY QUESTIONNAIRE

THE EXCEL PROGRAM
Excel in Science, Technology, Engineering, and Mathematics

Excel
Community Survey

Please answer the following items as they relate to your experiences in the EXCEL program at UCF.

1. Students in the EXCEL program care about each other
   ○ Strongly Agree ○ Agree ○ Disagree ○ Strongly Disagree

2. I feel valued as a person within EXCEL
   ○ Strongly Agree ○ Agree ○ Disagree ○ Strongly Disagree

3. I feel accepted as a part of the EXCEL community.
   ○ Strongly Agree ○ Agree ○ Disagree ○ Strongly Disagree

4. Faculty associated with this program care about students.
   ○ Strongly Agree ○ Agree ○ Disagree ○ Strongly Disagree

5. EXCEL Center programs foster positive relationships among the EXCEL participants
   ○ Strongly Agree ○ Agree ○ Disagree ○ Strongly Disagree ○ Not applicable

6. Living in the residence halls has raised my awareness of campus resources.
   ○ Strongly Agree ○ Agree ○ Disagree ○ Strongly Disagree ○ Not applicable

7. The institution's traditions and celebrations play an important role in my life as a student.
   ○ Strongly Agree ○ Agree ○ Disagree ○ Strongly Disagree

8. I have felt lonely at UCF.
   ○ Strongly Agree ○ Agree ○ Disagree ○ Strongly Disagree ○ Not applicable

9. My experience living in the EXCEL residence hall has increased my sense of belonging.
   ○ Strongly Agree ○ Agree ○ Disagree ○ Strongly Disagree ○ Not applicable

10. I live off-campus and feel included in the EXCEL community.
    ○ Strongly Agree ○ Agree ○ Disagree ○ Strongly Disagree ○ Not applicable

11. I am satisfied with the range of extracurricular activities available at UCF.
    ○ Strongly Agree ○ Agree ○ Disagree ○ Strongly Disagree

12. The EXCEL Center allows me to interfact with students like me.
    ○ Strongly Agree ○ Agree ○ Disagree ○ Strongly Disagree ○ Not applicable

13. I am satisfied with the range of extracurricular activities available within EXCEL.
    ○ Strongly Agree ○ Agree ○ Disagree ○ Strongly Disagree

14. EXCEL faculty and students work together to promote my learning.
○ Strongly Agree ○ Agree ○ Disagree ○ Strongly Disagree

15. EXCEL faculty are accessible to me when I seek their help.
○ Strongly Agree ○ Agree ○ Disagree ○ Strongly Disagree

16. The EXCEL Center provides services that enhance my academic success.
○ Strongly Agree ○ Agree ○ Disagree ○ Strongly Disagree ○ Not applicable

17. EXCEL graduate students are accessible to me when I seek their help.
○ Strongly Agree ○ Agree ○ Disagree ○ Strongly Disagree

18. EXCEL allows me to interact with people of different backgrounds.
○ Strongly Agree ○ Agree ○ Disagree ○ Strongly Disagree

19. I am proud of this institution's history and heritage.
○ Strongly Agree ○ Agree ○ Disagree ○ Strongly Disagree

20. My friends share my interests and values.
○ Strongly Agree ○ Agree ○ Disagree ○ Strongly Disagree

21. The EXCEL curriculum has made me interested in the study of math and science.
○ Strongly Agree ○ Agree ○ Disagree ○ Strongly Disagree

22. I am satisfied with the overall quality of instruction within the EXCEL program.
○ Strongly Agree ○ Agree ○ Disagree ○ Strongly Disagree

23. I often felt under a lot of stress during my time at this institution.
○ Strongly Agree ○ Agree ○ Disagree ○ Strongly Disagree

24. My social interactions tend to be mostly with students from the EXCEL program.
○ Strongly Agree ○ Agree ○ Disagree ○ Strongly Disagree

25. Sharing classes with other EXCEL students promotes studying together.
○ Strongly Agree ○ Agree ○ Disagree ○ Strongly Disagree

26. There is a strong sense of community within the EXCEL program.
○ Strongly Agree ○ Agree ○ Disagree ○ Strongly Disagree

Gender:
○ Male ○ Female

Please indicate any comments you have about the EXCEL Learning Community:

PID:

submit

APPENDIX D

UNIVERSITY SENSE OF COMMUNITY QUESTIONNAIRE

UCF Community Questionnaire

Please answer the following items as they relate to your experiences at UCF.

1. Students at this university care about each other
   Strongly Agree / Agree / Disagree / Strongly Disagree
2. I feel valued as a person at this institution
   Strongly Agree / Agree / Disagree / Strongly Disagree
3. I feel accepted as a part of the campus community.
   Strongly Agree / Agree / Disagree / Strongly Disagree
4. Faculty care about students.
   Strongly Agree / Agree / Disagree / Strongly Disagree
5. Programs foster positive relationships among students at this institution
   Strongly Agree / Agree / Disagree / Strongly Disagree / Not applicable
6. Living in the residence halls has raised my awareness of campus resources.
   Strongly Agree / Agree / Disagree / Strongly Disagree / Not applicable
7. The institution's traditions and celebrations play an important role in my life as a student.
   Strongly Agree / Agree / Disagree / Strongly Disagree
8. I have felt lonely at UCF.
   Strongly Agree / Agree / Disagree / Strongly Disagree / Not applicable
9. My experience living in residence halls has increased my sense of belonging.
   Strongly Agree / Agree / Disagree / Strongly Disagree / Not applicable
10. I live in an off-campus residence and feel included in the university community.
    Strongly Agree / Agree / Disagree / Strongly Disagree / Not applicable
11. I am satisfied with the range of extracurricular activities available at UCF.
    Strongly Agree / Agree / Disagree / Strongly Disagree
12. University programs allow me to interact with students like me.
    Strongly Agree / Agree / Disagree / Strongly Disagree / Not applicable
13. I am satisfied with the range of extracurricular activities available at this institution.
    Strongly Agree / Agree / Disagree / Strongly Disagree
14. The faculty and students in my courses work together to promote my learning.
    Strongly Agree / Agree / Disagree / Strongly Disagree
15. Faculty are accessible to me when I seek their help.
    Strongly Agree / Agree / Disagree / Strongly Disagree

16. The university provides services that enhance my academic success.
 Strongly Agree Agree Disagree Strongly Disagree Not applicable

17. Tutors are accessible to me when I seek their help.
 Strongly Agree Agree Disagree Strongly Disagree

18. The university allows me to interact with people of different backgrounds.
 Strongly Agree Agree Disagree Strongly Disagree

19. I am proud of this institution's history and heritage.
 Strongly Agree Agree Disagree Strongly Disagree

20. My friends share my interests and values.
 Strongly Agree Agree Disagree Strongly Disagree

21. The major curriculum has made me interested in the study of math and science.
 Strongly Agree Agree Disagree Strongly Disagree

22. I am satisfied with the overall quality of instruction within this institution.
 Strongly Agree Agree Disagree Strongly Disagree

23. I often felt under a lot of stress during my time at this institution.
 Strongly Agree Agree Disagree Strongly Disagree

24. My social interactions tend to be mostly with students from my classes.
 Strongly Agree Agree Disagree Strongly Disagree

25. Sharing classes with other students promotes studying together.
 Strongly Agree Agree Disagree Strongly Disagree

26. There is a strong sense of community at this institution.
 Strongly Agree Agree Disagree Strongly Disagree

27. Gender:
 Male Female

28.
Please indicate any comments you have about the UCF Community:

NID:

submit

APPENDIX E

INSTRUMENT EXPERT REVIEW PANEL

Table 19.

Panel of Expert Reviewers for ESOC and USOC Instruments

Reviewers role at institution	Area(s) of expertise
Interim Director, Faculty Center for Teaching and Learning	Mathematics, Program assessment, Instructional pedagogy
PI, NSF STEP Grant (EXCEL)	Electrical engineering, STEM, Datamining
Director, Operational Excellence and Assessment Support	Assessment of learning outcomes, Student engagement, Survey research methodology
Director, Engineering & Computer Science Academic Affairs	Retention, First-year, STEM

APPENDIX F

INSTITUTIONAL REVIEW BOARD (IRB)

APPROVAL FOR EXCEL

University of Central Florida

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901, 407-882-2012 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

EXPEDITED CONTINUING REVIEW APPROVAL NOTICE

From : **UCF Institutional Review Board**
FWA00000351, Exp. 5/07/10, IRB00001138

To : **Michael Georgiopoulos**

Date : **August 22, 2007**

IRB Number: **SBE-06-03511**

Study Title: **UCF STEP Pathways to STEM: From Promise to Prominence (EXCEL Program)**

Dear Researcher,

This letter serves to notify you that the continuing review application for the above study was reviewed and approved by the IRB Chair on 8/22/2007 through the expedited review process according to 45 CFR 46 (and/or 21 CFR 50/56 if FDA-regulated).

Continuation of this study has been approved for a one-year period. The expiration date is 08/21/2008. This study was determined to be no more than minimal risk and the category for which this study qualified for expedited review is:

7. Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Use of the approved, stamped consent document(s) is required. The new form supersedes all previous versions, which are now invalid for further use. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Subjects or their representatives must receive a copy of the consent form(s).

All data must be retained in a locked file cabinet for a minimum of three years (six if HIPAA applies) past the completion of this research. Any links to the identification of participants should be maintained on a password-protected computer if electronic information is used. Additional requirements may be imposed by your funding agency, your department, or other entities. Access to data is limited to authorized individuals listed as key study personnel.

To continue this research beyond the expiration date, a Continuing Review Form must be submitted 2 – 4 weeks prior to the expiration date. Use the Unanticipated Problem Report Form or the Serious Adverse Event Form (within 5 working days of event or knowledge of event) to report problems or events to the IRB. Do not make changes to the study (i.e., protocol methodology, consent form, personnel, site, etc.) before obtaining IRB approval. Changes can be submitted for IRB review using the Addendum/Modification Request Form. An Addendum/Modification Request Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at https://iris.research.ucf.edu .

On behalf of Tracy Dietz, Ph.D., UCF IRB Chair, this letter is signed by:

Signature applied by Janice Turchin on 08/22/2007 01:43:12 PM EDT

Janice M Turchin

APPENDIX G

STUDENT CONSENT FORM

INFORMED CONSENT TO PARTICIPATE

UCF-STEP Pathways to STEM: From Promise to Prominence

A research project is being conducted at the University of Central Florida and funded by the National Science Foundation on student learning in Science, Technology, Engineering and Math (STEM) by **Dr. Michael Georgiopoulos (School of EECS) and Dr. Cynthia Young (Department of Mathematics) and other investigators** at the University of Central Florida. The purpose of the study is to assess student learning using different teaching methods in Science, Technology, Engineering and Mathematics disciplines.

You are being asked to take part in this study by completing surveys and questionnaires throughout the program. Some of the surveys will be sent to you as e-mails and will take approximately 15 minutes of your time. To determine changes in learning that occurs in the content area, assessment questions will be tracked throughout the course. Other questionnaires will be completed during class by a person other than your instructor and the instructor will not have access to any of this data. These surveys will take approximately 5 minutes of class time each time. This will allow us to collect information on individual student learning within the program and relate it to content specific work. Please be aware that you are not required to participate in this research and you may discontinue your participation at any time without penalty. You may also omit any items on the questionnaires or surveys you prefer not to answer.

There are no risks associated with participation in this study. If you have further questions about your rights, information is available form the contact person listed at the end of this consent form. Your responses will be analyzed and reported by an external assessor to protect your privacy. If you agree to voluntarily participate in this research project as described, please indicate your agreement by completing and returning the attached consent form. Please retain this consent cover letter for you reference, and thank you for your participation in this research.

Institutional Review Board (IRB)
University of Central Florida (UCF)
12443 Research Parkway, Suite 207
Orlando, Florida 32826-3252
Telephone: (407)823-2901

Consent Form

Print Name:___________________________

I have read the "Informed Consent to Participate" and agree to allow Dr. Michael Georgiopoulos and Dr. Cynthia Young to use the information I provide to conduct their research titled 'UCF-STEP Pathways to STEM: From Promise to Prominence'

I am 18 years or older ❒

_______________________________ _________________________

Signature Date

APPENDIX H

LETTER OF APPROVAL FROM THE UCF’S

INSTITUTIONAL REVIEW BOARD

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901, 407-882-2012 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Notice of Exempt Review Status

From: **UCF Institutional Review Board**
FWA00000351, Exp. 10/8/11, IRB00001138

To: **Melissa D. Falls**

Date: **April 28, 2009**

IRB Number: **SBE-09-06224**

Study Title: **PSYCHOLOGICAL SENSE OF COMMUNITY AND RETENTION: RETHINKING THE FIRST-YEAR EXPERIENCE OF STUDENTS IN STEM**

Dear Researcher:

Your research protocol was reviewed by the IRB Vice-chair on 4/27/2009. Per federal regulations, 45 CFR 46.101, your study has been determined to be **minimal risk for human subjects and exempt** from 45 CFR 46 federal regulations and further IRB review or renewal unless you later wish to add the use of identifiers or change the protocol procedures in a way that might increase risk to participants. Before making any changes to your study, call the IRB office to discuss the changes. **A change which incorporates the use of identifiers may mean the study is no longer exempt, thus requiring the submission of a new application to change the classification to expedited if the risk is still minimal.** Please submit the Termination/Final Report form when the study has been completed. All forms may be completed and submitted online at https://iris.research.ucf.edu.

The category for which exempt status has been determined for this protocol is as follows:

4. Research involving the collection or study of existing data, documents, records, pathological specimens or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects. ("***Existing***" means already collected and/or stored before your study starts, not that collection will occur as part of routine care.)

No consent form used in this study.

All data, which may include signed consent form documents, must be retained in a locked file cabinet for a minimum of three years (six if HIPAA applies) past the completion of this research. Any links to the identification of participants should be maintained on a password-protected computer if electronic information is used. Additional requirements may be imposed by your funding agency, your department, or other entities. Access to data is limited to authorized individuals listed as key study personnel.

On behalf of Tracy Dietz, Ph.D., UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 04/28/2009 09:34:37 AM EDT

Joanne Muratori

IRB Coordinator

APPENDIX I

ESOC INITIAL SOLICITATION E-MAIL

Dear Melissa,

As part of the EXCEL program, we will occasionally ask you for information about your experiences. This is one of those moments! Your input and feedback are critical to the success of this program and your success at UCF.

We would appreciate you taking about **10 minutes** to complete the ***EXCEL Community Survey***. The survey asks questions regarding your experiences in the residence halls, your participation in university activities, and your feelings about the community in which you interact, all as they pertain to the EXCEL program. Your responses will remain confidential and will be summarized to get a more accurate picture of the larger EXCEL group.

To show our appreciation we are offering prizes! Each student who completes the survey by the **deadline of April 8th** will be placed in a drawing to win one of eight Barnes & Noble $25 gift certificates or one of two fall semester Prentice-Hall book scholarships. Yes, FREE textbooks!

To participate and share your experiences, the survey can be found at http://www.cecs.ucf.edu/acadaffairs/excel.html

Hope the first half of the semester has gone well and you are gearing up for the home stretch! If you need anything, do not hesitate to let us know.

Regards,

Dr. Cynthia Young &
Dr. Michael Georgiopoulos

EXCEL

APPENDIX J

USOC INITIAL SOLICITATION E-MAIL

Dear Melissa,

As part of the university, we will occasionally ask you for information about your experiences. This is one of those moments! Your input and feedback are critical to our improvement process and your success at UCF.

We would appreciate you taking about **10 minutes** to complete the ***UCF Community Survey***. The survey asks questions regarding your experiences in the residence halls, your participation in university activities, and your feelings about the community in which you interact. Your responses will remain confidential and will be summarized to get a more accurate picture of the larger university community.

To show our appreciation we are offering **prizes**! Each student who completes the survey by the **deadline of April 8th** will be placed in a drawing to win one of eight Barnes & Noble $25 gift certificates or one of two fall semester Prentice-Hall book scholarships. Yes, FREE textbooks!

To participate and share your experiences, the survey can be found at http://www.cecs.ucf.edu/acadaffairs/ucf.html

Hope the first half of the semester has gone well and you are gearing up for the home stretch! If you need anything, do not hesitate to let us know.

Regards,

CECS, COSAS, & BSBS
Advising Services

APPENDIX K

DATA ANALYSIS TABLES

Table 20.

Descriptive Statistics for ESOC Items 1 -25

Variable	N	Mean	Standard Deviation
STCARE	108	3.15	.561
VALUEDPER	107	3.15	.641
ACCEPTED	108	3.21	.627
FACCARE	108	3.47	.571
CTRPOSREL	108	3.06	1.012
RHAWARER	108	2.13	1.652
UCFTRADIT	108	2.74	.778
FELTLONELY	108	3.10	.985
RHSOBELNG	108	1.64	1.482
OFFINCLUDE	106	.94	1.393
COCURUCF	106	3.25	.618
CTRINTEREST	108	3.09	.815
COCURWXL	108	2.80	.758
FSWORKTO	106	3.28	.598
FACACCESS	107	3.44	.552
CTRSERVSU	108	3.27	.827
GAACCESS	108	3.26	.617
INTERACTDIV	108	3.23	.504
PROUDUCF	108	3.27	.574
FRNDSHRINT	107	3.20	.522
CURINTISM	105	3.00	.832
SATQULINST	108	3.23	.705
STRESS	108	2.24	.852
SOCWXLST	108	2.58	.908
SHCLSSTDY	108	3.31	.767
Valid N (listwise)	97		

Table 21.

Factor Analysis Communalities for ESOC Items 1 – 25

Variable	Initial	Extraction
STCARE	.581	.485
VALUEDPER	.749	.827
ACCEPTED	.708	.701
FACCARE	.536	.471
CTRPOSREL	.561	.674
RHAWARER	.705	.866
UCFTRADIT	.494	.404
FELTLONELY	.225	.062
RHSOBELNG	.644	.654
OFFINCLUDE	.599	.604
COCURUCF	.504	.417
CTRINTEREST	.519	.481
COCURWXL	.402	.373
FSWORKTO	.736	.787
FACACCESS	.669	.585
CTRSERVSU	.621	.581
GAACCESS	.591	.546
INTERACTDIV	.596	.523
PROUDUCF	.575	.721
FRNDSHRINT	.494	.300
CURINTISM	.604	.488
SATQULINST	.699	.680
STRESS	.354	.276
SOCWXLST	.540	.999
SHCLSSTDY	.635	.580

Table 22.

Factor Correlation Matrix from ESOC Factor Analysis

Factor	1	2	3	4	5	6
1	1.000					
2	.600	1.000				
3	.499	.679	1.000			
4	-.222	-.327	-.169	1.000		
5	.552	.603	.481	-.136	1.000	
6	.180	.530	.439	-.138	.476	1.000

Table 23.

Descriptive Statistics for USOC Items 1 – 25

Time	N	Mean	Standard Deviation
STCARE	98	3.01	.442
VALUEDPER	98	3.11	.451
ACCEPTED	98	3.14	.592
FACCARE	98	3.15	.563
PRPOSREL	96	2.95	.933
RHAWARER	97	2.32	1.604
UCFTRADIT	98	2.90	.711
FELTLONELY	98	2.10	.914
RHSOBELNG	98	1.87	1.448
OFFINCLUDE	98	.98	1.377
COCURUCF	98	3.29	.609
UNVINTERST	97	2.95	.834
COCURINST	97	3.24	.591
FSWORKTO	98	3.04	.536
FACACCES	97	3.18	.629
UNVSERVSU	97	3.37	.546
TTRACCESS	97	3.20	.687
INTERACTDIV	98	3.29	.658
PROUDUCF	97	3.22	.505
FRNDSHRINT	97	3.22	.581
CURINTSM	98	3.40	.756
SATQULINST	98	3.21	.613
STRESS	98	2.99	.767
SOCWSTNCL	98	2.64	.888
SHCLSSTDY	97	3.07	.665

Table 24.

Variables and Coding in the ESOC Regression Model

Block/Variable	Code
Block 1	
Gender: male (DUMGNDR)	0 = female; 1 = male
Ethnicity: White (DCWHITE)	0 = other; 1 = white
Ethnicity: Hispanic (DCHISP)	0 = other; 1 = Hispanic
Ethnicity: Black (DCBLCK)	0 = other; 1 = Black
Ethnicity: Asian (DCASIAN)	0 = other; 1 = Asian
SAT: out range low (DUMSATOL)	0 = other; 1 = SAT out-of-range low
SAT: in range low (DUMSATIL)	0 = other; 1 = SAT in-range low
SAT: in range high (DUMSATIH)	0 = other; 1 = SAT in-range high
High school GPA: high (DHSGPAH)	0 = other; 1 = high school GPA high
High school GPA: medium (DHSGPAM)	0 = other; 1 = high school GPA medium
Block 2	
College: CECS (DCECS)	0 = other; 1 = CECS
College: COS (DCOS)	0 = other; 1 = COS
First term GPA: above strong (D1TRMAS)	0 = other; 1 = first term GPA above strong
First term GPA: strong (D1TRMST)	0 = other; 1 = first term GPA strong
First term GPA: moderately strong (D1TRMMS)	0 = other; 1 = first term GPA moderately strong
Block 3	
Math course (DUMCLSS)	0 = pre-calculus; 1 = calculus
Block 4	
Residence: LC (DXLLC)	0 = other; 1 = EXCEL learning community
Residence: on-campus (DONCMPS)	0 = other; 1 = on-campus
Block 5	
Open acceptance (FOPENACPT)	4-point scale: 1 – 4
Academic system interaction (FADCMCINT)	1 = strongly disagree; 4 = strongly agree
Student academic support services (FACSPPRTS)	
Social system interaction (FSOCINT)	
Residential experience (FRESEXPOS)	
Dependent variable	
Sense of community (SOC)	4-point scale: 1 – 4 1 = strongly disagree; 4 = strongly agree

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