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## A Comparative Investigation Of Career Readiness And Decidedness In First Year Stem Majoring Students Participating In A Stem Mentoring Program Imbedded In A Living-learning Community With Focused Data On Female Stem Students

Nirmala Ramlakhan  
*University of Central Florida*



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A COMPARATIVE INVESTIGATION OF CAREER READINESS  
AND DECIDEDNESS IN FIRST YEAR STEM MAJORING STUDENTS  
PARTICIPATING IN A STEM MENTORING PROGRAM IMBEDDED  
IN A LIVING-LEARNING COMMUNITY WITH FOCUSED DATA  
ON FEMALE STEM STUDENTS

by

NIRMALA DEVI RAMLAKHAN  
B.S. University of Central Florida 2002  
M.S. University of Central Florida 2005

A dissertation submitted in partial fulfillment of the requirements  
for the degree of Doctor of Education  
in the Department of Educational Research, Technology, and Leadership  
in the College of Education  
at the University of Central Florida  
Orlando, Florida

Fall Term  
2012

Major Professor: Bobby J. Jeanpierre

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## ABSTRACT

Female mentoring success was investigated as an undergraduate intervention utilizing career development practices to reduce dysfunctional career thinking and STEM major retention in first year freshmen females within a living-learning community. Repeated measures MANOVAs and canonical correlations in the causal comparative research design evaluated mentoring's influence on first year females. Male voluntary participants (n = 126) formulated the comparison group, and female voluntary participants (n = 75) filled the treatment group. Repeated measure multivariate analyses of variances compared differences between the interaction of mentoring and gender over time on dysfunctional career thinking using two assessments: Career Thoughts Inventory (CTI) and Career Decision Scale (CDS) and their five subscales (decision-making confusion, commitment anxiety, external conflict, certainty and indecision). Canonical correlations analyzed the effect participation rates had on student change scores on the CTI and CDS, indicating mentoring intervention effects on reducing dysfunctional career thinking and decidedness. Conclusions included: (a) females had higher levels of dysfunctional career thinking than males; (b) overtime both groups decreased dysfunctional thoughts, and solidifying their STEM career choices; (c) females had reduced levels of career decidedness compared to males; (d) both groups increased certainty overtime, solidifying their STEM career choice, and (e) when the STEM career choice was made, female certainty was more solidified than males. The study adds to the career development research within STEM at the undergraduate level providing colleges and universities with a structured first year female mentoring program in STEM. The

GEMS model may be ideal for colleges and universities utilizing living-learning communities to increase underrepresented female retention and those without STEM career planning courses.

To my mother and my first teacher, Amala Radhika Ramlakhan,  
who always said, “There is one thing no one can take from you: your education.”

I love you and thank you for supporting my dreams.

## ACKNOWLEDGMENTS

Many individuals have shaped this dissertation and my future career. The encouragement, support, guidance, and positive energy of my chair, Dr. Bobby Jeanpierre, has taken me successfully through my doctoral career and the dissertation process. Dr. Andrew Daire gave this research focus and helped link my passion for talent and workforce development in STEM to the world of career development. This dissertation allowed me to mesh my career and academic life. Without the forum, logistical support and friendship of Drs. Michael Georgiopoulos, Cynthia Young and Melissa Falls, this research would not exist, and Dr. Michael Hynes, through his soft manner, thwarted my fears, supporting me and believing I could successfully finish the process even when I didn't. Finally, I attribute the completion of this dissertation to the person who started the flow of words. The first and hardest to generate words of this dissertation were written under the leadership of Dr. David Boote.

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## CHAPTER 1 INTRODUCTION

### Background

The nation needs to develop a stronger and more diverse workforce using Science, Technology, Engineering and Mathematics (STEM) talent and career development as the vehicle (American Association of State Colleges and Universities, 2005; Babco, 2004; Beede, Julian, Langdon, Mckittrick, Doms, 2011; Business-Higher Education Forum, 2005; The National Academies, 2006; National Science Board [NSB], 2010; National Science Foundation, 2005. Embedded in this statement are factors that may affect underrepresented females, retention, recruitment, career readiness, career decidedness, mentoring, and functioning in living-learning communities for STEM students and workers. Though STEM comprises a complex array of topics, this study sought to examine only the relationship between STEM retention needs for first-year STEM majoring students, analyzing career readiness and decidedness and using female mentoring within a STEM living-learning community as the vehicle for STEM career and talent development.

Despite increases in STEM academic research, studies examining and evaluating the effectiveness of STEM interventions are sparse. Broad questions surrounding STEM abound in the literature pertaining to (a) effective use of grant dollars, (b) appropriate interventions for varied populations of students, e.g., gender, rural, urban, age, (c) how success in STEM is defined and (d) what tools should be used to analyze effectiveness (Baker, 1998; Daempfle, 2003; NSF 2007; Seymour & Hewitt, 1997). Answers are not

easily acquired in response to these questions as population, gender, geography, cost, and time factors contribute to researched outcomes. Furthermore, additional educational disparities, also present within STEM, such as equity, access, and questions within underrepresented population recruitment and retention abound in academic and mainstream literature (Bae, Choy, Geddes, Sable, Synder, 2000; Adams, 2012; U. S. Department of Education, 2012). Creation and funding of STEM programming without research-supported answers to these questions may lead to mismanagement of resources. Filling gaps in STEM research for already depressed groups and underrepresented disadvantaged populations is paramount to U.S. talent and career development success and desired by both academicians and politicians. The National Science Foundation (NSF) and other leading educational research institutions and government offices have documented access and retention shortfalls within STEM careers and majors (National Science Board [NSB], 2010a, b). Therefore, this dissertation sought to add to the literature determining the effects of mentoring, career decidedness and readiness in retention within first-year STEM-majoring students.

### Statement of Problem

STEM talent and career development shortfalls represent, at their core, supply and demand issues. Simply put, the United States has not produced enough STEM-proficient staff to meet industry need (Babco, 2004; Business Roundtable, 2005; Information Technology Association of America, 2005; The National Academies, 2006; NSB, 2010, 2012; U.S. DOLETA, 2007; U.S. GAO, 2005; 2006; U. S. DOLETA, 2007). The

importance of STEM talent and career development comprises part of the respective political platforms with both 2012 presidential candidates' touting the need for jobs, education, and energy alternatives. The recent recession placed STEM at the forefront of the national agenda, because only STEM-related careers are dubbed recession proof (Florida Department of Economic Opportunity, 2012; Kelly, 2012). Increased recruitment and retention of U.S. students into STEM majors and careers enables the U.S. to meet international competitive demands by: (a) increasing STEM-proficient staff to meet employer demands; (b) reducing need for offshore research, development and manufacturing due to lack of qualified U.S. staff; and (3) decreasing reliance and recruitment of foreign nationals for high-tech positions (Hira, 2010; Feller, 2011; Kelly, 2012; NSF, 2010; Obama for America, 2012).

Although, career theory offers explanations to how and why persons persist and provides suitability characteristics by career (Gati et al., 1996; Sampson et al., 1999), sparse research exists within career theory and STEM talent and career development. Furthermore, examining career readiness and decidedness of females within STEM-majors is virtually non-existent in academic literature. Strategic interventions focused on retention through career development practices may, however, increase persistence of STEM-majoring students. Researchers in business and psychology literature have shown that a reduction in dysfunctional career thinking increased retention (Gati et al., 1996). Mentoring within living-learning communities (LLC) increases retention. These research-supported strategies provide success for students in many academic areas and may also lead to retention success for STEM-majoring first-year students (Campbell &

Campbell 1997; Kahle, Parker, Rennie & Riley, 1993; Pascarella & Terezzi, 1991; Tinto, 2003). Though, mentoring and LLC literature have depicted increased academic success and retention rates, no studies researching the effects of career development strategies when coupled within these interventions. Furthermore, though researchers have shown females as underrepresented, and recruited and retained at lower rates than their male counterparts in STEM, few studies examine the effectiveness of mentoring and LLCs on female first-year retention (NSF, 2008). With fewer numbers of females viewing STEM as a career option and an attrition rate of 40% by graduation (Chen & Weko, 2009), reduction of dysfunctional career thinking is necessary to ensure adequate numbers of STEM professionals in the United States (Feller, 2011; Hiro, 2010). This study aimed to contribute to filling STEM career and talent development gaps present in U.S. universities by embedding research-supported mentoring, LLCs, and gender strategies within career development theory to reduce dysfunctional career thinking and increase retention of first-year STEM-majoring students within a living-learning community.

### *Talent and Career Development Gap in STEM*

Shortfalls in STEM talent and career development are an economic crisis impacted by high attrition and low recruitment rates of STEM students and workers. The United States is not producing enough STEM-proficient staff to meet industry need (National Science and Technology Council, 2006; NSB, 2010, 2012; U.S. DOLETA, 2006; U.S. GAO, 2005, 2006). Though shifting labor demands showed enormous



outsourcing during the period of 2000-2011 (National Science Board [NSB], 2010), political and economic pressures within the U.S. have pushed companies to bring jobs back within America's borders. From 2000 to 2010, the need for STEM jobs increased by 7.9%, rising to 7.6 million (5.5% of the U.S. labor force). This growth in STEM demonstrated an increase of three times the rate of other fields and is expected to grow an additional 17% from 2008 to 2018 compared with 9.8% for other jobs according to a 2011 U.S. Department of Commerce report (Langdon, McKittrick, Beede, Khan, & Doms (2011). According to this report, growth in STEM jobs over the past 10 years has been three times as fast as growth in non-STEM jobs. The U.S. GAO (2005) reported employment in STEM fields rose from an estimated 7.2 million to around 8.9 million in the years between 1994 and 2003; an increase of about 23% during a time when non-STEM employment rose only 17%. The Bureau of Labor Statistics projected significant growth in the overall STEM workforce between 2007 and 2014 with 17 of the 20 fastest-growing occupations in STEM (U.S. DOLETA, 2007). Projected through 2012, labor experienced 70% growth in Science and Engineering occupations and by 2014, employers expect to hire 2.5 million new STEM workers (Lacey & Wright, 2009) In fact, Florida had 42,539 unfilled STEM positions, in January 2012, for occupations such as biological scientists, computer software engineers, industrial engineers, and actuaries (Help Wanted Online, FL STATE Department of Economic Opportunity). STEM employer need is high while unemployment levels within STEM are lower than other industries despite recent recession. Ranging from 1.8% to 5.3% from 2007-2010 in STEM fields while non-STEM workers saw rates of 4.8% to nearly 10% during the same

period (Career Path, 2012). Despite documented STEM labor demands U.S. colleges and universities cannot meet talent needs due to low recruitment and retention within STEM (ACT, 2006; American Association of State Colleges and Universities, 2005; Information Technology Association of America, 2005; The National Academies, 2006; NSB, 2010).

### *Post-Secondary STEM Gap*

Low undergraduate recruitment and retention drives supply shortfalls within STEM talent and career development at the national level. Though numbers of awarded STEM degrees have increased over the past five years, only 15.6% of U.S. bachelor's degrees were awarded in STEM, a decrease in the overall share of degrees awarded in STEM from previous years. Meanwhile, China awarded nearly half of its university degrees in STEM fields (46.7%); South Korea awarded 37.8%, and, Germany awarded 28.1% (National Science Board, 2010b). Further describing subpar retention in STEM, roughly 71% (2.7 million) of the 3.8 million ninth graders graduated in the United States in 1997. Of these, only 62% (1.7 million) enrolled in two- or four-year colleges (Cominole, Siegel, Dudley, Roe, & Gilligan, 2006; Goan & Cunningham, 2006). By 2007, only 13% (233,000) of these students earned a STEM bachelor's degree (NSB, 2010b). Additionally, though underrepresented minority groups comprised 28.5% of the national population in 2006, only 9.1% of those represent college-educated workforce individuals in science and engineering occupations, suggesting the proportion of underrepresented minorities in science and engineering occupations would need to triple

to match their share of the overall U.S. population (NRC, 2011). Furthermore, although women make up almost half of the United States workforce, they account for only 24% of the US STEM workforce (Beede et al., 2011; NSF, 2010). Though females in STEM earn 33% more than females in comparable non-STEM positions, with a smaller gender-wage gap in STEM jobs, recruitment and retention within K-20 STEM courses of study demonstrated no significant increase (Beede et al., 2011; Langdon et al., 2011; NSF, 2010). Lack of recruitment, retention, and training within STEM adversely impacts business and industry's sustenance of a STEM career pipeline. Furthermore, increased economic global competition and national safety concerns added pressure the K-20 system to fix STEM educational gaps in the pipeline.

### *Gender Gap in STEM*

The chasm between supply and demand for STEM-proficient talent can be minimized through systematic recruitment and retention efforts in underrepresented populations, namely females. Looking at gender as a barrier, Beede et al. (2011) posited female disparities in STEM are caused by the lack of female role models, gender stereotyping, and less family-friendly flexibility. The underrepresentation of women in STEM has remained consistent over the past decade despite increases in the college-educated workforce (ESA census data, 2000, 2009). As a movement in the right direction, the frequency of females within some STEM careers has steadily increased since 2000 (36% in 2000 to 40% in 2009) within forensics, life sciences, and chemistry related jobs. However, presently within engineering, women only comprise one of every

seven engineering jobs; this number includes the 12,000 additional women engineers since 2000 (Organization for Economic Cooperation and Development [OECD], 2012).

Seymour and Hewitt (1997) in their text focused on why undergraduates leave the sciences, stated that, nationally, 40% of students who enter an engineering major are not retained, with 50% leaving the physical and biological sciences and 60% leaving mathematics majors. Females and minorities experience disproportionately larger losses. Reasons given by undergraduates who left the sciences or engineering include: (a) discouraged/loss of confidence due to low grades in early years, (b) morale undermined by competitive STEM culture, (c) Curriculum overload, overwhelming pace, (d) poor teaching by STEM faculty, (e) inadequate advising or help with academic programs, and (f) loss of interest in STEM, e.g., turned off by science (Seymour & Hewitt, 1997).

At urban universities nationwide, the percentages of females who declare and retain in STEM disciplines have lagged behind men (NSF, 2010). Males in STEM disciplines outpaced females by a factor of 2:1 during a four-year period (2002-2006) at the large urban university in the Southeastern U.S. that houses this study. The same holds true throughout the nation (NSF, 2010). Furthermore, numbers of female STEM graduates from first-year student cohorts to their graduating senior year lags behind male retention rates, with attrition as high as 40% (Seymour & Hewitt, 1997). In harder disciplines such as computer engineering, computer science, electrical engineering, and mechanical engineering, females represent only 10% of the total STEM graduates at many universities.

### *Mentoring and Living-Learning Communities in STEM*

Committing to a career choice is a paramount psychosocial task for college students (Campbell & Cellini, 1981; Gati et al., 1996; Folsom & Reardon, 2000). Evidence suggests women and minorities respond best in more collaborative learning experiences which include working with mentors (Green & King, 2001). Mentoring programs and living-learning communities (LLC) are research-supported retention strategies within undergraduate degree programs, as they foster higher sense-of-community and provide academic support (Campbell & Campbell, 1997; Tinto, 2003). Though sparse research on effects of STEM-centered LLC with mentoring components is available, effective uses of mentoring and LLC's as separate interventions leading to increased retention and academic success abound (Astin, 1975, 1995; Cohen, 1995; Girves, Zepeda, Gwathmey, 2005; Kuh, Schuh, Whitt, and Associates, 1991; Pascarella, 1980; Pascarella & Terrenzini, 1991; Noel, Levitz, Salluri, and Associates, 1985). Many learning communities do more than co-register students around a topic. They change the manner in which students experience the curriculum and the way they are taught (Gahlenick, MacGregor, Matthews, & Smith, 1990). Mentoring programs offer direct career assistance and provide information and social-emotional support, thereby assisting first-year students in their transition from high school (Hubard, 2011).

#### Purpose of Study

Low numbers of STEM graduates coupled with decreased numbers of diverse populations as STEM workforce entrants define the STEM talent development problem

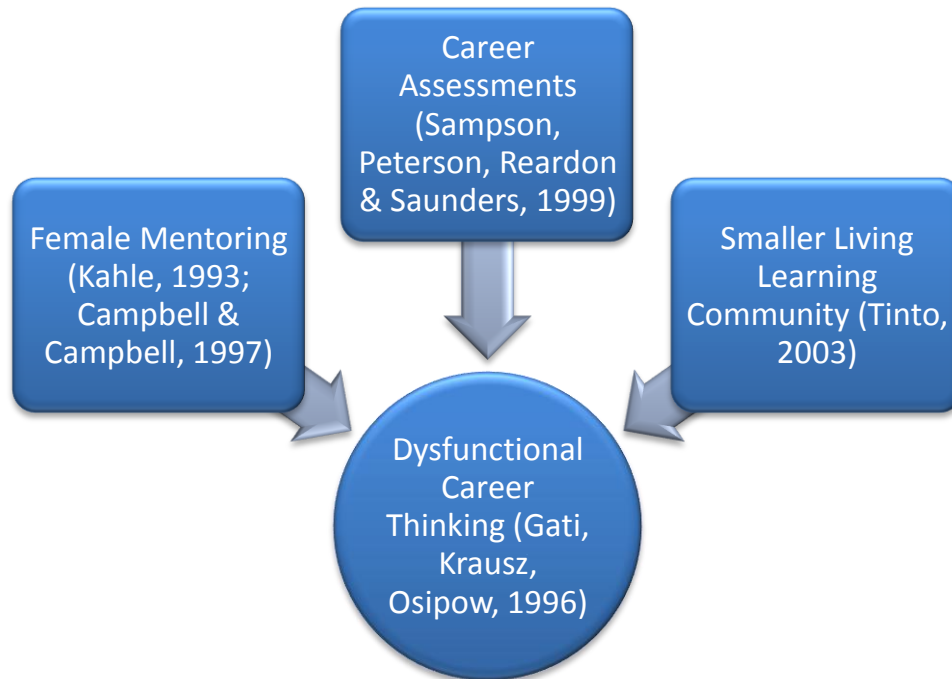
faced today (NSB, 2010). Sufficient numbers of STEM-proficient individuals do not exist at each level in the STEM-career ladder (NSB, 2010b; NSB, 2012). Thus, in response to need expressed by national agendas, industry, and academic entities for career and talent development in STEM, this research study sought to investigate the effect an all-female mentoring program had on career readiness and career decidedness on first year STEM majoring college students with Mathematics Scholastic Assessment Test (SAT) scores between 550 and 650.

The research study examined mentoring program effects when situated within an already functioning smaller living-learning community at a large urban university. In assessing the effect of the GEMS (Girls Excelling in Mathematics and Science) mentoring program on dysfunctional career thinking and career decidedness, the overarching research study goal, the researcher aimed to offer a model to universities. Model success occurred when increased retention of female undergraduate STEM-majoring first year was garnered through identification of students in need of intervention as determined by levels of dysfunctional career thinking. The GEMS (Girls Excelling in Mathematics and Science) mentoring program, is a part of a larger National Science Foundation funded STEM living-learning community called the STEM-LLC.

### Theoretical Framework

The theoretical underpinning for this study hedges dysfunctional career thinking interventions of first-year STEM-majoring freshman females within a mentoring program with increased decidedness and retention as goals. The creation of Girls Excelling in

Mathematics and Science (GEMS) intervention aimed to increase STEM talent and career development, using gender, career thinking, mentoring, and living-learning community postulates. Tinto's (2003) research on LLC's and Campbell & Campbell's (1997) mentoring research informed the creation of the mentoring intervention within the LLC. Kahle et al.'s (1993) gender constructs informed selection of mentors, mentees, and programmatic offerings within GEMS. The assessments of Sampson et al. (1999) gauged career decidedness and thinking, and Gati et al.'s (1996) career decidedness theory provided the intervention framework and programmatic design. Examining the effect of female mentoring on dysfunctional career thinking and using the Career Thoughts Inventory (CTI) and the Career Decision Scales (CDS), levels of dysfunctional career thinking and decidedness was gathered three times during the first year, as the highest attrition rate in STEM-majors occurs at this point in a student's undergraduate career (NSF, 2009). Figure 1 depicts the theoretical framework for the study.



*Figure 1.* Theoretical Framework for the Study

Campbell and Campbell's (1997) study on mentoring and student success supported by Green and King's (2001) study on unrepresented populations both exhibit retention success when mentoring is employed. Study outcomes showed mentoring: (a) promoted student success (Campbell & Campbell, 1997; Kahveci, Southerland, & Gilmer, 2006; Sorrentino, 2007), (b) promoted unrepresented population's success (Green, Evans, & King, 2001), (c) developed relationships in a variety of formal and informal forms (Levinson, Carrow, Klein, Levinson, & McKee, 1978; Luna & Cullen, 1995; Phillips-Jones, 1982), and (d) positively relate to student outcomes such as grade point average and college persistence (Campbell & Campbell, 1997; Kahveci et al., 2006; Pagan & Edwards-Wilson, 2003; Salinitri, 2005; Sorrentino, 2007; Wallace, Abel, &



Ropers-Huilman, 2000). Using researcher outcomes stated above, GEMS was created to:

- (a) promote student success through increased academic and social interactions with faculty and mentors;
- (b) promote success for underrepresented populations (females) through programmatic offerings aimed at removing barriers detailed in Chapter 2;
- (c) strengthen faculty and mentor bonds in formal meetings and informal social gatherings;
- (d) increase academic standing through tutoring and advising.

The absence of a consistent, comprehensive definition or operational definition of mentoring has repeatedly been acknowledged as a limitation of research attempting to relate mentoring to outcomes (Dickey, 1996; Johnson, 1989; Miller, 2002; Rodriguez, 1995). Because mentoring research suffers from definitional, methodological, and theoretical flaws making it difficult to measure accurately mentoring's impact on student success (Crisp & Cruz, 2009; Jacobi, 1991), the researcher deliberately and systematically addressed limitations within GEMS program creation and implementation.

Kahle et al.'s (1993) macro-framework on the role of gender in science education was used as the lens to view (a) first year STEM female student retention issues, (b) mentoring as a vehicle for academic advancement in underrepresented populations, and (c) career decision-making difficulties within STEM majoring students. Kahle et al.'s (1993) model systematically examined variable effects on girls' interest, confidence, achievement, aspiration, and retention in science. Kahle et al. (1993) posited that gender's role in science is situated within society's expectations of males and females, science, and practice, philosophy and aims of educational organization, curriculum, image, and sex-difference. Use of Kahle et al.'s (1993) model in cross-cultural research,

such as this study, comparing males to females, creates opportunities for the intervention to challenge student beliefs, prior experiences, and behavior. Observable outcomes permit methodical evaluation on the effect of interest, achievement, aspiration, and retention in GEMS and the STEM-LLC. Kahle et al.'s (1993) feedback loop between professors, mentors, and mentees facilitates parts of the GEMS, Girls Excelling in Mathematics and Science, intervention. Strategic situation of GEMS within the STEM-LLC follows Tinto's (2003) research into living-learning communities (LLC) and provides a framework to analyze the effectiveness of the mentoring intervention. Tinto (2003) and Gablenick et al. (1990) posited that LLCs change the manner in which students experience curriculum and the way they are taught. In LLCs, faculty reorganize syllabi and classrooms to promote shared, collaborative learning experiences among students. This form of classroom organization requires students to work together in some form of collaborative groups and to become active, indeed responsible, for the learning of both group and classroom peers. In this way, students are asked to share not only the experience of the curriculum but also of learning within the curriculum (Tinto, 2003). Tinto's (2003) conception of LLCs guided the STEM-LLC creation in which the GEMS mentoring program resides. The mentoring component, GEMS, was created and named with the guidance of STEM-LLC faculty, staff, and students. GEMS subdivided the STEM-LLC population into female mentoring groups facilitating relationship building which, according to Pascarella & Terenzini (1991), leads to undergraduate retention. Mentoring activities in the STEM-LLC challenged female misconceptions about ability and success in science and STEM (Kahle et al, 1993). Reduction of dysfunctional career

thinking in students facilitates retention in students (Gati et al., 1996). This study sought to use reductions in dysfunctional career thinking to facilitate retention in first-year STEM-majoring students. Career development theory, detailed in the literature within psychology, business, and education, was sparse within STEM literature.

Gati et al. (1996) developed an empirically tested decision-theory model which not only characterizes the career readiness and decidedness difficulties of individuals, but also informed this study. Extensions of the Gati et al. (1996) model were made to the STEM sample in this study as the model contains broad categories for analysis and is not specifically tied to particular careers. The model includes three broad categories, subdivided into 10 smaller categories and based on 44 specific difficulties. The first difficulty category is lack of readiness which consists of lack of motivation, general indecisiveness, and dysfunctional beliefs and relates to difficulties that arise before engaging decision-making. The second category, lack of information, includes lack of knowledge about steps involved in the process of forming a career decision, lack of information about self, various occupations, and ways of obtaining additional information. The third category, inconsistent information, pertains to unreliable information, internal conflicts, and external conflicts. Gati et al. (1996) echoed findings of American and Israeli samples using empirical structures when studies were re-run (Gati et al., 1996; Gati, Osipow, Krausz, & Saka, 2000; Osipow & Gati, 1998; Shiloh & Shenhav-Sheffer, 2004).

Therefore, taken collectively, analysis of the mentoring intervention to address the gap in STEM talent and career development at the undergraduate level used Campbell and Campbell's (1997) mentoring study, Kahle et al.'s (1993) gender framework and Gati et al.'s (1996) career model. Both assessments, the Career Thoughts Inventory (CTI) and the Career Decision Scale (CDS), facilitated interpretation of decision-making confusion, commitment anxiety, external conflict, decidedness and indecision within the STEM-LLC, and GEMS intervention.

### Study Significance

Assessing effects of the GEMS (Girls Excelling in Mathematics and Science) mentoring program on dysfunctional career thinking and career decidedness adds to the sparse body of research on career development needs for first-year students majoring in STEM. The researcher aimed to offer a model to universities that may increase retention of female first-year STEM majors by identifying students in need of intervention as determined by predominance of dysfunctional career thinking. The intervention measured in this study was the GEMS mentoring program. GEMS is situated within an NSF STEP Grant funded STEM living-learning community (STEM-LLC) which began in 2006. NSF has funded over 80 such living-learning communities throughout the nation. Situating the intervention within an already researched environment, the STEM-LLC, allows this researcher to support NSF's goal of sustainability, not through funds, but rather through increased programmatic effectiveness and STEM retention of

underrepresented populations. Increased retention may lead other funded STEM-LLCs to attain institutionalization and outside funding support.

Examining the role career decidedness and career thinking have on STEM-major retention, through the lens of a mentoring, contributes to the literature in the following ways:

1. Adding to the research on first year female retention within STEM majors
2. Adding to of gender-based mentoring literature at the undergraduate level
3. Understanding of the role career theory plays in gender and STEM major retention of first year students
4. Adding to the sparse research on career development within STEM talent development

### Overview of Research Design

The study used a comparative research design with repeated measures MANOVAs and canonical correlations to measure influences of the GEMS, Girls Excelling in Mathematics and Science, mentoring program on career readiness and career decidedness among students. The research study was conducted over a nine-month period with quantitative data derived from valid and reliable career assessments collected at specific time markers. Only after receiving approval for the research by the Institutional Review Board of the University of Central Florida (Appendix A) was the research initiated.

### Research Questions

Investigation into the effect of mentoring on dysfunctional career thinking and career decidedness, and subsequent retention of first-year STEM-majoring females within an LLC, formed the foundation for this research study and was encompassed in the following four research questions:

1. What effect did the GEMS (Girls Excelling in Mathematics and Science) mentoring program have on career readiness as measured by the Career Thoughts Inventory?
2. What effect did the GEMS (Girls Excelling in Mathematics and Science) mentoring program have on career decidedness as measured by the Career Decision Scale?
3. What effect did participation in the GEMS (Girls Excelling in Mathematics and Science) program have on career readiness as measured by participation levels and the Career Thoughts Inventory?
4. What effect did participation in the GEMS (Girls Excelling in Mathematics and Science) program have on career decidedness as measured by participation levels and the Career Decision Scale?

### Null Hypotheses

1. No differences exist in career readiness, as measured by the CTI, between GEMS and non-GEMS study participants.

2. No differences exist in career decidedness, as measured by the CDS, between GEMS and non-GEMS study participants.
3. No relationship exists between GEMS participation and changes on the CTI.
4. No relationship exists between GEMS participation and changes on the CDS.

### Setting

This study was conducted within a large metropolitan university in the southeastern United States with about 60,000 diverse undergraduate students. Large population of minorities and females, populations traditionally underrepresented in STEM, were present at the university.

### Variables

The independent variables for the first two research questions were gender, date of test administration and treatment (female) versus comparison (male) groups. The dependent variables were the assessment scores. The dependent variables for the third and fourth research questions were change scores between test administration one (August) and three (April) for both assessments with the independent variables as participation points. Participations points correlated to the number of events a mentee (female) attended.

### Population

The population for the research study was the population for the STEM-LLC, 201 males and females. A total of 75 females (treatment) comprised the intervention group, and 126 males (comparison) participated in the STEM-LLC.

### Limitations

One limitation of this study occurred from the lack of a truly experimental research design, as the sample was not fully randomized and a comparison group of males, rather than control group of analogous females, was used. Additionally, due to design, there is no way to tell if decreases in attrition and dysfunctional career thinking constitute gender gap reductions or are inherently due to gender differences.

### Key Definitions

Definitions of terms pertinent to this research are explicated in this section.

STEM--STEM is a broad term used to define a range of disciplines. The National Science Foundation (NSF) (2007) has defined STEM fields broadly, including both mainstream and non-mainstream categories of STEM. The mainstream categories are comprised of mathematics, natural sciences, engineering, computer, and information sciences. NSF extends the definition to include the following non-mainstream categories of social/behavioral sciences such as psychology, economics, sociology, and political science (Green, 2007). Many recent federal and state legislative efforts limit this definition to include only mathematics, natural sciences, engineering, and technologies.



The limited definition is designed to focus education and teaching to standardized testing subjects (Kuenzi, Matthews, & Mangan 2006; National Governors Association 2007).

Recruitment into STEM—occurs at the undergraduate level occurs when a student declares a major or course of study within STEM at the time of acceptance into a university according to NSF (2007). Additionally, the 2003–04 National Postsecondary Student Aid Study [NPSAS] (2006) and the Education Longitudinal Study of 2002/06 [ELS] (2002) use this recruitment definition to include a student’s reported major, and considers anyone a STEM entrant if that student has reported a major (first or second major if that information is available) in a STEM field at any time during his or her postsecondary enrollment (Cominole et al., 2006). Undecided majors and science or mathematics education majors are not counted as STEM majors (Cominole et al., 2006). The National Center on Education Statistics also adopted the aforementioned definition in its longitudinal study of Students Who Study STEM (Chen & Weko, 2009). Though this definition may limit certain groups of students within education or undecided majors from being counted, this study utilizes cited precedence for consistency of analysis.

Talent development--a term used within industry and workforce development comprises the training, coaching, and empowerment of employees to move up on a career pathway and is a part of career development (U.S. DOLETA, 2010).

Career development--the entire sequence of activities and events related to an individual's career, encompassing the acquisition of educational qualifications and certifications, career pathways, self-actualization as an individual, shifting of careers and

career growth, learning curves, family life effects, accomplishments, and recognitions or felicitations (Kleiman, Gati, Peterson, Sampson, Reardon, & Lenz, 2004).

Talent development--cannot occur in STEM without recruitment, retention, and career development of students at the undergraduate level. Therefore, the two terms are inextricably linked with interventions within career development leading to talent development within industry.

Girls Excelling in Mathematics and Science (GEMS)--the name of the mentoring intervention. Girls, rather than females, are used in the title of the intervention as the pilot group of mentors and mentees voted on the name. Within this research study, females are used when referring to the population, and girls is referenced only in the title of the mentoring intervention.

Underrepresented populations in STEM industries--females, minorities (some research excludes Asians), and students from low socioeconomic backgrounds (U.S. DOLETA, 2010).

Mentoring--“a formalized process whereby a more knowledgeable and experienced person actuates a supportive roles of overseeing and encouraging reflection and learning within a less experienced and knowledgeable person, so as to facilitate that person’s career and personal development” (Roberts, 2000, p. 162).

STEM persistence--the retention and completion of students in STEM majors.

STEM pipeline--the numbers of individuals on a STEM career path and are desirous of working in a STEM career or course of study. The pipeline provides workforce entrants multiple access and exits points.

STEM career development--the progress of an individual through a STEM career ladder.

Career indecision--a construct been used to refer to the problems individuals may have in making their career decision (Slaney, 1988a).

Decision making--according to the normative theory of the best decision, the one that best helps to achieve the decision maker's goals. These goals are represented by the individual's preferences with respect to the various attributes of the alternatives under consideration. A rational career decision maker should choose the alternative with the highest utility, where the utility of each alternative is a function of the perceived gap between the individual's preferences and the alternative's characteristics in each of these attributes. Utility theory is a normative model that may be regarded as a prescription for the best method for making decisions (Brown, 2002).

Ideal career decision maker--a person who is aware of the need to make a career decision, is willing to make it, and is capable of making the "right" decision, i.e., a decision using an appropriate process and most compatible with the individual's goals (Brown, 2002).

STEM-LLC--the living-learning community that houses the GEMS females mentoring intervention at the university and started in 2006. The STEM-LLC the goal was to increase student success and retention in a STEM discipline.

STEM Disciplines, defined by NSF as Chemistry, Computer Science, Engineering, Environmental Science, Geosciences, Life Sciences, Mathematics, and Physics/Astronomy.

STEM Learning Communities--a group of people who share common emotions, values or beliefs, are actively engaged in learning together and from each other, and by habituation in STEM-related fields. Such communities have become the template for a cohort-based, interdisciplinary approach to higher education.

### Summary

Context for the study including problem, purpose, significance, overarching theoretical framework, research questions, definitions, and limitations were provided in Chapter 1. Chapter 2 delineates relevant research supporting the need for this research and what is known already within the STEM talent and development problem. Chapter 3 include the methodology and explanation of STEM-LLC, the GEMS intervention, and instruments used in this study. Chapter 4 provides analysis of data and results. A detailed discussion of results is presented in Chapter 5 along with implications of the research and recommendations for future research.

## CHAPTER 2 LITERATURE REVIEW

### Introduction

Global competitive advantage and secure economic standing achieved through STEM talent and career development enables the United States to grow a stronger more diverse workforce (Beede et al., 2011; NSB, 2010). Many factors are required to come together to achieve high levels of STEM talent and career development. This study, however, was conducted to explore a solution at the intersection of career readiness and decidedness using female mentoring within a living-learning community as the vehicle for STEM retention. Substantial amounts of literature are available related to career development, mentoring and smaller living-learning communities, and to a lesser degree, female STEM undergraduate retention. Based on a review of relevant literature, however, no researcher had investigated the role dysfunctional career thinking plays in female retention using mentoring as the intervention. Thus, this study contributes to filling the STEM talent and career development gap, answering research questions by couching the problem within the theoretical underpinning that guided the GEMS intervention.

## Research Questions

To review, the research questions answered by this study were:

1. What effect did the GEMS (Girls Excelling in Mathematics and Science) mentoring program have on career readiness as measured by the Career Thoughts Inventory?
2. What effect did the GEMS (Girls Excelling in Mathematics and Science) mentoring program have on career decidedness as measured by the Career Decision Scale?
3. What effect did participation in the GEMS (Girls Excelling in Mathematics and Science) program have on career readiness as measured by participation levels and the Career Thoughts Inventory?
4. What effect did participation in the GEMS (Girls Excelling in Mathematics and Science) program have on career decidedness as measured by participation levels and the Career Decision Scale?

Roles of mentoring as a retention practice, smaller living-learning communities, female STEM needs, and career thinking constitute major subtopics. Coupling Tinto's(2003) research on smaller living-learning communities with Campbell and Campbell's (1997) mentoring study fostered the creation of GEMS (Girls Excelling in Mathematics and Science) within the STEM-LLC. Internal program structure designed to increase female participation and retention, such as schedules, activities, networking events, and talking points for mentoring meetings, were guided by Kahle et al.'s (1993) gender framework. Identification and analysis of career decidedness and thinking were

driven by Gati et al.'s (1996) model and assessed using Sampson et al.'s (1999) assessment tools. Investigations into the aforementioned sub-topics guided quantitative analyses in Chapter 4 and provided a lens through which to view intervention success in Chapter 5.

Divided into five sections, using the theoretical framework to guide the literature review, Chapter 2 analyzed research study components including breadth and depth of relevant available research. The first section analyzes the need for STEM talent, career, and workforce development. The second section reviews career development theory, the role of career development within undergraduate studies, and career development's role within science education literature, mentoring, and STEM. The third section examines factors within STEM, including gender differences and needs, factors influencing STEM major selection and retention, and barriers to entry and completion. Section four reviews existing research in mentoring, namely, the emergence of mentoring within business, psychology, career development, and educational literature. Also examined in this section is mentoring as a vehicle for academic success, assessments measuring effectiveness of mentoring programs, gender-based mentoring programs, mentoring in science education and the emergence of STEM-based mentoring. Finally, the fifth section examines research pertaining to the role smaller-living-learning (LLC) communities play in fostering sense-of-community (SOC), the role of smaller-living-learning communities within universities, and mentoring programs couched within smaller living-learning communities.

Delineation of literature sections was driven by the theoretical framework that frames this study. Specifically, Tinto's (2003) research on LLCs and Campbell & Campbell's (1997) mentoring research informed the creation of the mentoring intervention within the LLC and informed sections four and five of this chapter. Kahle et al.'s (1993) gender constructs framed section three of the review, selection of mentors, mentees, and programmatic offerings within GEMS. Sampson et al.'s (1999) assessments gauged career decidedness and thinking, and Gati et al.'s (1996) career decidedness theory provided the intervention framework and programmatic design and framed section two of the review. Depth of research and ideas presented in this review sufficiently met the literature review needs identified by research questions. Using this narrow focus, the researcher did not address the breadth and depth of available research within career development theory, mentoring, STEM, and undergraduate retention factors.

### STEM Talent and Career Development

Talent and career development are subsets of a larger workforce development issue encompassing unemployment, skills upgrades, industry diversification, training, retention, and recruitment (U.S. DOLETA, 2007). This section of the review examined expressed needs within U.S. workforce development through the lens of undergraduate STEM talent and career development. Traditional peer-reviewed journals and non-peer reviewed sources were included in the review, as research is so new and changing that much relevant discussion is housed in policy discussions, speeches, reports and articles.



Because STEM as a national agenda item is relatively new, research studies framing and defining STEM workforce development were sparse, hence the need for this study. Prior academic literature addressed areas termed SME (science, mathematics, and engineering) with the strongest historical push occurring during the sputnik era (Deboer, 1991). The fervor for STEM workforce development currently rivals that of the 1950s, as economic development, government, special interests, and education are all involved in solving STEM needs (Beede et al., 2011; NSF, 2010, U.S. DOLETA, 2007). Further depicting the current need for research over the past 10 years, numbers of publications included in the ERIC database using search terms, “STEM,” “workforce,” and “development” delivered only 14 peer-reviewed sources between January, 2005 and December, 2011. In comparison to the Academic Search Premier database, 17 references were found between 2003 and 2011 using the search terms “STEM,” “workforce,” and “development.” Therefore, with national agendas and industry reporting a need for increases in STEM workforce, including recruitment and retention at all levels of the STEM career pipeline, more research into factors affecting STEM talent and career development were paramount.

STEM talent development, a subset of workforce development, and a national economic development push by President Barack Obama, consists of recruitment, retention, and training needs from cradle to career (Obama for America, 2012; U.S. DOLETA 2006, 2007, 2008, 2011). Emphasizing (a) recruitment of students into STEM courses of study in K-16, (b) recruitment of dislocated workers and females into STEM careers, (c) retention of K-16 students in STEM majors of study, and (d) training of

dislocated or incumbent workers for movement up the STEM career pipeline make up the national agenda (Obama for America, 2012; U.S. DOLETA, 2006, 2007, 2008, 2010, 2011).

As the U.S. economy slowly rebuilds, the cry for job creation has grown louder. Communities faced with poverty, high unemployment rates, and high rates of unskilled and underrepresented labor pools are most concerning for governmental groups. Many workforce development shortfalls situate the lack of STEM-proficient staff available to meet employers' demand in recruitment and retention gaps (NSF, 2007, 2009; NSB 2010; U.S. DOLETA, 2007, 2008, 2010, 2011). Researchers and economists argue that poverty and unemployment rates would reverse current trends if the supply of STEM-proficient staff were available. Feller (2011) supported this point, stating that the U.S. culture has embraced an attitude of "exceptionalism through birthright," (p.08) rather than one of hard work and self-sacrifice. Workplace change without talent development is disruptive to stable employment, secure organizations, and predictable career trajectories (Feller, 2011). STEM occupations, as defined by Shatkin (2009), require knowledge of or skill with science, technology, engineering, or mathematics with at least two years of postsecondary study or training. STEM opportunities, driven by the disciplines of chemistry, computer science, engineering, geosciences, life sciences, mathematics, physics/astronomy, and social sciences, cover a wide range of careers. Despite varied academic backgrounds and levels of career ladder opportunities, all STEM careers have the commonality of shared skills and knowledge in the areas of science, technology, engineering, and mathematics. Although many careers have some integration of these

areas, STEM career workers largely use knowledge of one or more STEM subjects in their day-to-day activities (Shatkin, 2011).

Hira (2010), echoing the statements of many, agreed that there is no need to belabor the importance of the STEM workforce, as it is a broadly accepted belief. Scientific and technical workforce play critical roles in increasing standards of living, ensuring national security, and solving some of society's most pressing problems (Hira, 2010). Though STEM workers represent only about 5% of the nation's workforce, there exists a widespread belief among policy makers and academic and business leaders that STEM workers have a disproportionately higher impact on the nation, solving problems from global warming, and terrorism to national and global economic competitiveness (Hira, 2010). A 2008 study by the Interagency Aerospace Revitalization Task Force concluded lack of U.S. students with strong skills in STEM subjects, added to a retiring aerospace workforce, could equal a catastrophic shortage of skilled workers. To combat this dilemma, legislative policies have specifically targeted changing the size and characteristics of the STEM workforce in an effort to increase national and global impacts and STEM talent and career development (Beede et al., 2011; Hira, 2010; NSF, 2010).

STEM talent and career development shortfalls are a supply and demand issue at its core. Simply, the United States is not producing enough STEM-proficient staff to meet industry need (U.S. DOLETA, 2007, 2008, 2010, 2011; U.S. GAO, 2005, 2006; NSB, 2010, 2012). There is no shortage of jobs in STEM fields. In fact, while overall U.S. unemployment is rising, STEM industries maintain surplus job openings due to the

lack of qualified applicants (U.S. DOLETA, 2010). Supporting Hira's (2010) argument, industry drives the demand to increase the amount of STEM workers to greater than 5%. Compare these unemployment rates for STEM workers: 1.8% in 2007, up to 5.5% in 2009 and dipping to 5.3% in 2010. For non-STEM workers, the rates were 4.8% in 2007, 9.5% in 2009 and nearly 10% in 2010 (Career Path, 2012). Furthermore, with the advent of the recent recession, only STEM-related careers were dubbed recession proof (Podgornik, 2012). According to the Bureau of Labor Statistics, by 2014 employers are expected to hire 2.5 million new STEM workers. In fact, as of January of 2012, Florida had 42,539 unfilled STEM positions in occupations such as biological scientists, computer software engineers, industrial engineers, and actuaries (Florida Department of Economic Opportunity, 2012). Over the past decade, STEM jobs grew three times as fast as non-STEM jobs: 7.9% compared to 2.6%. Between 2008 and 2018, STEM jobs were expected to jump 17%, while their non-STEM counterparts were expected to rise by only 9.8% (Career Path, 2012).

Providing additional support for the STEM talent and career development supply shortfall, according to the U.S. GAO, employment in STEM fields rose from an estimated 7.2 million to around 8.9 million in the years between 1994 and 2003--an increase of about 23% during a time when non-STEM employment rose by only 17%. The Bureau of Labor Statistics projected significant growth in the overall STEM workforce between 2007 and 2014, speculating that of the 20 fastest-growing occupations over the coming decade, 17 will be in health care and computer fields. The overwhelming majority of the last decade's expansion in STEM employment was in

computer and mathematics fields (78%) as opposed to science (only 20% growth) or engineering fields (no apparent growth). Getting sufficient numbers of individuals qualified for advanced education in STEM is one challenge, but connecting qualified and skilled workers to jobs in their fields is also problematic, particularly in science and engineering. A 2007 NSF report indicated that two-thirds of workers with science and engineering degrees were employed in positions somewhat or not at all related to their educational expertise.

Shifts in workforce patterns and downward trends in economic indicators have fueled STEM, providing \$3,440 million in grant-funded opportunities during 2010 (The White House, 2012); with funding agencies hopeful resulting programs increase STEM recruitment and retention. Supporting federal agency dollars, such as the National Science Foundation STEP grant, started the STEM-LLC that houses this study's intervention, GEMS. Individual state agendas have echoed STEM importance, funding programs designed to increase recruitment and retention. Considering Florida, where this study was based, in 2009 alone, \$894,000 U.S. Department of Labor state pass-through dollars were allocated to STEM for programs ranging from camps and curriculum development to state-level STEM offices and grants. This figure does not include funding from industry groups and the Florida Department of Education, whose dollars mainly support universities, school districts, and governing boards supported in STEM industry growth and development.

However, based on the lack of peer-reviewed research available in regard to STEM recruitment and retention, a firm understanding of what constitutes a successful

intervention is not available. Therefore, effectiveness of funded programs is anecdotal at best, as many resulting programs are not externally evaluated; hence, the need for this study. It is not uncommon, however, for increased funding and curricular development in science and technology education to be promoted during periods of economic downturn with evaluation following. Using Australia as an example, there was a clear correlation between the economic depressions of the 1890s, 1930s, and 1980s and significant developments in technology education. It is not implausible that the global financial crisis of 2007-2009 was a stimulant for STEM workforce development policies and funding with evaluation to come later (Williams, 2011).

Creating a funded mandate, the U.S. government places importance on STEM talent development. The importance of STEM as a national agenda item cannot be shown more clearly than when the 111<sup>th</sup> U.S. Congress passed H.R.1709, the STEM Education Coordination Act of 2009, on June 8, 2008. The Act established a committee under the National Science and Technology Council with the responsibility for coordinating science, technology, engineering, and mathematics education activities and programs for all federal agencies. The following congressional resolutions and bills framed the STEM talent and career development need at a national level: (a) HR 6104 (2008) aims to coordinate state and federal STEM initiatives, increasing number of students entering the STEM workforce, addressing the need to diversify the STEM increasing women and underrepresented groups; (b) H.R. 2272 (2007) seeks the director of the National Science Foundation to award up to 200 grants promoting master's degrees in STEM subjects, developing strategies more women and underrepresented minority

groups into STEM industries; (c) HR 3634 (2007) was an amendment to the Higher Education Act of 1965 which provides incentives for students to pursue STEM-related degrees in the form of scholarships and loan forgiveness, (d) HR 4137 (2007) amends the Higher Education Act of 1965, revising and reauthorizing HEA programs; Section 309 of the amendment addresses STEM workforce development needs, establishing the YES Partnerships grant program to foster projects promoting the pursuit of STEM-related careers among underrepresented K-12 students, and allocates funding for STEM ad particularly directed toward Latin-Americans, African-Americans and women. Though academic research is needed to determine resulting initiative effectiveness and success, high federal funding levels depict the importance of research into STEM talent and career development.

Duncan (2009), in supporting the STEM national agenda, policies and bills, stated

Most of our scientists and most of our STEM teachers are being recruited from a narrow segment of our population. We must find a way to include the people who represent the sum of our nation's population. If we can tap into the diversity of America, we can bring fresh ideas and perspectives and perhaps new inventions to our world. (p. 1)

According to Chen and Weko (2009), only 23 % of first-year college students declare a STEM major or 15% of the total student population of 3.6 million (college and non-college); and only 40 % of those who elect STEM majors in their first year receive a STEM degree within six years (about 6% of the total 3.6 million student population).

Further corroborating the supply problem addressed in this dissertation and need for analysis of career-oriented STEM research; Duncan (2009) argued “The right STEM strategies have the potential to have an enormous impact... [to] restore America's competitiveness we must recruit a new generation of science and technology leaders by investing in diversity” (p. 1). Therefore, to maintain the United States economy as a leader in the global marketplace, retention of underrepresented populations (females) in STEM is relevant. Retention practices and opportunities to provide career development interventions, thereby reducing dysfunctional career thinking within undergraduate STEM-majoring students, constituted one piece of the STEM puzzle addressed through this study. A component need of STEM-major retention lies in the identification of and interventions for populations showing high levels dysfunctional career thinking. In this study, researched populations were comprised of first-year STEM-majoring students.

### Career Development

STEM talent deficits within the U.S., as a supply and demand issue, have resulted in a need for career focused interventions specifically designed to address female underrepresentation in STEM. Low incidences and lack of literature in STEM career development and STEM mentoring further supported the need for this research. Understanding the interplay between career thinking, decidedness, living-learning communities, female underrepresentation, and mentoring enabled this intervention to partially fill the STEM talent gap within the U.S. The female mentoring intervention, GEMS, integrates the concepts of Campbell & Campbell (1997), Kahle et al. (1993), and



Tinto (2003) about mentoring, gender, and living-learning communities in Gati et al (1996) career decision making framework.

Career development and dysfunctional career thinking research is prevalent in business, psychology, and educational literature but absent within STEM. Various researchers have cited the reduction in dysfunctional career thinking as a vehicle for retention in various career paths within student and workforce populations (Brown, 2002; Gati et al., 1996; Kleiman, Gati, Peterson, Sampson, Reardon, & Lenz, 2004). This study used these career development findings to determine if reduced dysfunctional career thinking increased retention in first-year STEM students. Specifically, did first-year female undergraduate students, who scored between a 550 -650 on the Mathematics SAT and participated in an undergraduate mentoring program at a large urban university, exhibit higher levels of career readiness, as measured by the Career Thoughts Inventory, and career decidedness, as measured by the Career Decision Scale, than their male counterparts?

Gati et al.'s (1996) empirically tested decision-theory model, characterizing career readiness and decidedness difficulties of individuals, was used as the theoretical underpinning for the design of the GEMS (Girls Excelling in Mathematics and Science) intervention. Previous research literature reviewed, pertaining to the types of students who choose STEM and why they persist, supported the use of Gati et al.'s (1996) model as the sample for this study was comprised of university students at the beginning of their career decision making process.

Gati et al.'s model includes three broad categories, subdivided into 10 subcategories and based on 44 specific difficulties. This study analyzed career thinking results along within each broad category and six (of the ten) subcategories. The first difficulty category outlined by the researchers was lack of readiness, consisting of lack of motivation, general indecisiveness, and dysfunctional beliefs related to difficulties arising before decision-making. Determination of readiness was assessed within the intervention, GEMS, using the Career Thoughts Inventory (CTI). The second category, lack of information, included lack of knowledge about steps involved in the process of forming a career decision, lack of information about self, various occupations, and ways of obtaining additional information. Levels of decidedness within GEMS were captured on the Career Decision Scale (CDS). Interventions designed to impact lack of knowledge were programmatic in nature and were not quantitatively assessed. The third category, inconsistent information, pertained to unreliable information, internal conflicts, and external conflicts, again captured using the CTI and CDS. Within the stated three broad categories, GEMS specifically addressed and assessed the following subcategories within Gati et al.'s (1996) model: indecisiveness, lack of knowledge about the career decision making process, lack of information about occupations, ways to obtain career information, internal conflicts, and external conflicts. Literature presented deepens the understanding of Gati et al.'s (1996) broad and subcategories within STEM, expanding on factors that contribute to STEM major selection and characteristics and demographics of students who major in STEM.

### *Factors Contributing to STEM Career Selection*

According to 2010 NSB indicators, low numbers of STEM graduates coupled with decreased diversity of STEM workforce entrants defined the STEM talent development problem faced in the 21<sup>st</sup> century. Sufficient numbers of STEM-proficient individuals do not exist at each level in the STEM-career ladder (NSB, 2010ab, 2012), and policy discussions generally overlook the key component of the talent pool, incumbent workers (USDOLETA, 2007). This study sought to impact future underrepresented STEM incumbent worker retention through interventions for current STEM workforce entrants. Though some fields have improved their gender representation, women represented only 10.4% (< 1 in 9) of all engineers in 2003. For example, women represented 37.4% of all natural scientists and managers in 2003, up from just 20.9% in 1983. In other fields, the disparities have worsened. By 2003, women represented only 29% of all computer and mathematical scientists, down from their 30.7% share in 1983 (Commission on Professionals in Science and Technology [CPST], 2006b). Though women are making gains in some STEM degrees such as biological and agricultural sciences, they have remained severely underrepresented in mathematics and computer sciences fields (CPST, 2006b; Hira, 2010).

Rewards, salary, influence attractiveness of STEM occupations serve as an impetus for recruitment into STEM careers. As discussed by Ellis (2007), Report 5 of the STEM Workforce Data Project provided salary trends for occupations between 1995 and 2005. These data indicated that most STEM workers were paid significantly higher than workers in average occupations. In 2005, the median STEM pay was \$56,500 versus

\$34,000 for all occupations. STEM salary growth, however, has not outperformed other occupations. Between 1995 and 2005, STEM salaries grew approximately 6%, equaling the pace of all occupations. This finding would appear to contradict the widespread belief that STEM workers are persistently in short supply because, if they were, their wages would be bid up faster than those for other occupations. Instead, salary changes indicate relatively balanced supply and demand at the aggregate level (Hira, 2010). However, the comparative increases in STEM wages may be due to low numbers of sufficiently qualified STEM-workers competing for vacancies, leading employers to compensate at lower rates for lower qualifications.

Risk and uncertainty also affect the attractiveness of STEM occupations and careers. Though difficult to measure, recent changes in perceived risks have impacted STEM career choices. According to the 2009-2010 Taulbee Survey (Computing Research Association, 2011), enrollments in bachelor's degree programs in computer science dropped 40% from 2001 to 2006 due to rising risks for job loss in information technology (IT). Caused in part by outsourcing, this was a major factor in students shying away from computer science degrees. Other factors, such as the dot-com "bubble burst" and record unemployment levels for IT workers were also important (Computing Research Association, 2011). Unfortunately, though these factors were mitigated, undergraduate enrollment did not increase, supporting the need for STEM talent and career development research to determine successful recruitment and retention interventions (Hira, 2010).

Committing to a career choice is an essential psychosocial task for college students (Campbell & Cellini, 1981; Folsom & Reardon, 2000; Gati et al., 1996) and researchers have shown that undergraduate career courses have increased retention rates. Career courses result in reduction of dysfunctional career thinking and career indecision while increasing career decidedness and vocational identity, including gains in self-concept, and self-esteem (Folsom, Peterson, Reardon, & Mann, 2002; Folsom & Reardon, 2000; Johnson & Smouse, 1993). Additionally, students who complete an undergraduate career planning course have had higher graduation rates as compared with the general student population (81% compared with 69%). They have graduated with fewer credit hours on average than the general population (110 compared with 132), thus saving time and money due to their earlier entry into the workforce (Folsom et al., 2002; Osborne, Howard, & Leierer, 2007). In the review of researched and documented career course success literature, no incidence of universities having career interventions for STEM-majoring students was found.

Identifying students' dysfunctional career thinking comprises the first step in the career development process, and the next step involves interventions designed to increase readiness and reduce difficulties once the career decision is made (Kleiman et al., 2004). Kleiman et al. have also described the necessity of intervention evaluation to determine effectiveness, interactions with career decision making style, locus of control, and career decision-making self-efficacy to determine effectiveness. Rather than implementing an additional career class within the STEM-LLC, the GEMS mentoring model included

career development concepts from the literature in activities, mentor-mentee meetings and advising.

Kleiman et al. (2004) also prescribed key needs for career development interventions, and these were deliberately embedded within the GEMS female mentoring program. The key needs were as follows: (a) identify and assess deliberate thoughts and difficulties in the career decision; (b) develop interventions to increase readiness and decrease difficulties; (c) evaluate effectiveness of interventions and possible interactions of characteristics (career decision making style, locus of control, and career decision-making self-efficacy). These key needs were addressed in the creation of the GEMS (Girls Excelling in Mathematics and Science) intervention:

1. Identification of thoughts were garnered from Career Thoughts Inventory and Career Decision Scale, mentor meeting notes, mentee reflections and academic advising.
2. Interventions designed to increase readiness were tutoring, networking events, socials and faculty interaction outside of the classroom.
3. Time-bound CTI and CDS assessments garnered effectiveness or reduction of dysfunctional thinking as did other qualitative metrics stated in the first key need.

### *Undergraduate STEM Major Selection*

Understanding characteristics of students who select a STEM major, when it is selected, and retention trends supported the creation of the GEMS intervention. The main reasons undergraduate students leave STEM majors are (a) discouraged/loss of confidence due to low grades in early years; (b) morale undermined by competitive STEM culture; (c) Curriculum overload, fast-paced, overwhelming; (d) poor teaching by STEM faculty; (e) Inadequate advising or help with academic programs; and (e) loss of interest in STEM, being turned off by science (Seymour & Hewitt, 1997). Factors related to discouragement, advisement and loss of interest were directly addressed in the intervention through increased advising, tutoring, social and academic support from peers, faculty and GEMS staff.

Despite concerns of female's underrepresentation in science career pursuits, few longitudinal studies were conducted to determine who comprised the student profile in STEM until the late 1980s. The National Post Secondary Student Aid Study of 2003-2004 [NPSAS], 2006) and the Beginning Postsecondary Students Longitudinal Study of 2001 [BPSLS] (96:01) are among the few studies reporting enrollment and retention rates of female STEM students.

The NPSAS in 2003/2004 (NCES, 2006b), using a nationally representative undergraduate student sample spanning all ages, determined 14% of all undergraduates enrolled in U.S. postsecondary institutions in 2003-2004 were in STEM. This included 5% in computer/information sciences, 4% in engineering and engineering technologies,

3% in biological or agricultural sciences, and less than 1% each in physical sciences and mathematics.

The BPSLS of 1996-2001(NCES, 2001) followed the enrollment of beginning postsecondary students over six years, creating a clearer picture of U.S. STEM-major selection and the undergraduate STEM picture. Based on the 2001 study, 23% of beginning postsecondary students entered a STEM field at some time during their postsecondary enrollment from between 1995-96 and 2001. A total of 77% of 1995-96 beginning postsecondary students never entered a STEM field during their enrollment through 2001, including 72% who entered only non-STEM fields and 5% who never declared a major. In STEM fields, a higher percentage of students entered biological/agricultural sciences, engineering/engineering technologies, and computer/information sciences (an average of 7.5%) than mathematics and physical sciences (less than 2% for each).

#### *Demographics and STEM Career Pursuit*

Career theorists have accepted demographics such as gender, socioeconomic status, and ethnicity influence career choice (Gottfredson, 1981; Lent, Brown, & Hackett, 1994; Yoo, 2005). More students from above average SES homes tend to persist in science related fields; perhaps due to the increased prestige science related careers hold (Hilton, Miller, & Brown, 1991; Maple & Stage, 1991). Farmer, Wadrop, Anderson, & Risinger (1995), however, found that science career persistence related more to ethnicity differences. Based on NSF data (1997), Farmer et al., (1995) expected minorities from



inner city schools to be less prepared to enter and persist in science fields than their suburban counterparts.

Diverse and contradictory findings on socioeconomic status (SES) or ethnicity as the driving factors or barriers to entry for science related career persistence were found in research conducted by Hannah and Kahn (1989), Trusty, Robinson, Piata, and Ng (2000), and Ware and Lee (1988). Both parents' education level was also shown to be a factor for white females, but only the mother's educational level was a factor for African American females (Gruca, Ethington, & Pasarella, 1988). The aforementioned characteristics pertaining to career choice and selection have also been influenced by inherent STEM retention and recruitment issues. A component need of STEM talent and career development lies in identifying factors leading to retention and recruitment.

### Role of Gender in STEM Recruitment and Retention

Female underrepresentation in STEM, low numbers of overall STEM talent within the U.S. and the desire of economists to maintain global competitiveness framed the need for this study. Lack of research into factors that increase STEM retention further supported the need for this study. Understanding the roles of career thinking, decidedness, living-learning communities, female underrepresentation and mentoring on STEM retention partially fills the gap found in the literature review. Presented literature situates the STEM recruitment and retention problem as a career development issue providing insight into attitudes, perceptions, and self esteem as gender differences in STEM major selection. The STEM female mentoring intervention, GEMS, situates

Campbell and Campbell (1997), Gati et al. (1999) and Tinto's (2003) mentoring, career decision making framework, and living-learning communities as concepts using Kahle et al.'s (1993) gender framework as the lens to view retention factors.

In September 2005, then Secretary of Education, Margaret Spellings, formed a commission to study the future of higher education. In its findings, the commission revealed a bleak forecast that by 2010 the U.S. would produce less than 15% of all STEM talent down from 50% in 1960 (Hong & Shull, 2010; U.S. Department of Education, 2006). To further compound this economic crisis and provide a rationale for this study, students who elect to major in STEM face one of the highest attrition rates when compared to other programs (NPSAS, 2006). Approximately 50% of students who enroll in these fields do not complete their engineering education. They either switch their majors or drop out of college entirely (Ohland, Zhang, Thorndyke & Anderson, 2004). According to Wulf (2007), one of every two students will drop out of the program by the time their first introductory mathematics or engineering course is completed. This downward trend has drawn intense attention by higher education administrators to intentionally and proactively seek institutional changes designed to keep students in STEM fields (NSF, 2004b). Although these changes purport increased student retention, relatively stagnant, not evaluated, results exist. Few, if any, institutional reforms have led to significant modes of retention (Hong & Shull, 2010). This study embeds a female mentoring program, GEMS, within an institutionalized STEM-LLC at a large urban university. Retention shortfalls present in the U.S. are mirrored within the diverse student population. Therefore, with NSF funding, the university created a living-learning

community(LLC), targeting students who scored between 550 and 650 on their mathematics SAT. Though the STEM-LLC experienced increased retention since inception in 2006, underrepresented populations continue to be retained at lower rates than their male counterparts (Georgiopoulos et al., 2009). Presented in this section of the literature review are factors leading to female STEM retention and recruitment situating presented research in Kahle et al.'s (1993) gender framework as the theoretical underpinning. Understanding factors that increase female persistence in STEM guided the creation of GEMS.

Kahle et al.'s (1993) model can be used to systematically examine variable effects on female interest, confidence, achievement, aspiration, and retention in science. Kahle et al. (1993) suggested gender's role in science is situated within society's expectations of males and females, science and practice, philosophy and aims of educational organization, curriculum, image and sex-difference. Use of Kahle's (1993) model allows for comparison of males to females, creating opportunities to challenge student beliefs, prior experiences, and behavior through the GEMS mentoring intervention. Evaluation of the intervention effect on career thinking, interest, achievement, aspiration, and retention in GEMS and the STEM-LLC (Kahle, 1993) is garnered through Kahle et al.'s feedback loop and assessment analysis.

Beginning in the 1960s, the growth of civil rights and related social and gender movements in the United States accentuated demands for equality in education and society. Questions of fairness, equity, and democratic participation--particularly in regard to women, minorities, and other marginalized or disenfranchised groups--became

central issues on the public agenda. These developments also drew attention to practice and represented attention shortfalls within the “gendered” nature of science and technology in U.S. universities, politicizing, and framing disparities as a social problem. Punctuating the problem were increases in women earning advanced science, technology, engineering, and mathematics (STEM) degrees in significant numbers. It was assumed that, in time, women would achieve faculty representation proportionate to their level of participation. However, related progress has occurred much more slowly than expected (Valian, 1998, 2005). Though the number of women earning advanced STEM degrees has risen, women remain underrepresented at all ranks of the academic hierarchy in STEM fields with men remaining significantly overrepresented in the professoriate (CPST, 2009; Hahm, 2006; Long, 2001; McNeely & Vlaicu, 2010; National Academy of Sciences [NAS], 2007).

An extensive body of research explaining why women have historically-entered STEM fields at lower rates than men, how women’s experiences differ during STEM training, and the differential career paths of women in academic positions exists, (Etzkowitz, Kemelgor, & Uzzi, 2000; Fox, 2001; NAS, 2007; Rosser, 2004; Xie & Shauman, 2003). These researchers suggest varieties of simultaneous conditions have to be met for recruitment programs for women in science and technology fields to succeed. For such efforts to have plausibility, credible career opportunities for women have to be visible, incentives have to exist, a supply of qualified women needs to be available, and organizational policies supporting women have to be in place, to name a few (Rosser & Taylor, 2009; Tilghman, 2004; Wotipka & Ramirez, 2003).

Despite efforts devoted to recruitment and retention, the low supply of females interested in STEM has perpetuated talent and career development shortfalls, attributed to student perceptions and experiences, at all levels in the STEM pipeline. Although interest and ability are major considerations of females choosing a STEM major, Takruri-Rizk, Jensen, and Booth (2008) found it is more difficult to understand why students may not be drawn to STEM fields. Possessing family members in the engineering or technology industry also played an important part in students' degree choice. Robinson (2003) indicated students who took advanced placement (AP) courses in science or calculus selected STEM careers at a higher rate than other careers. Even though more students may enroll in a STEM major, persistence of students in STEM majors remains a problem (Daempfle, 2003). Seymour (1995) noted quality of teaching in science classes impacts persistence, attributing attrition to students' being unprepared (Seymour & Hewitt, 1997; Strenta, Elliott, Adair, Matier, & Scott, 1994). Still, even well-prepared students leave science, mathematics, and engineering majors because of, what they perceived as, poor instruction, undesirable curricular structure using one-way lectures, and faculty who valued their research above teaching (Seymour & Hewitt, 1997). Springer, Stanne, and Donovan (1999) summarized a number of efforts to improve STEM courses, such as small-group learning.

In addition to increasing student proficiency in STEM subjects, the United States must increase students' interest in STEM majors and careers (Beede et al., 2011; NSF, 2010). Both interest in a STEM career and proficiency in STEM subjects, especially mathematics, are prerequisites for students to select and succeed in a STEM major (Hira,

2010; NSF, 2010). Research by ACT indicates that fewer than one in five 12th graders have displayed both high interest in STEM and high proficiency in mathematics, precursors to success in STEM undergraduate programs (ACT, 2011). Twelfth graders who demonstrated high proficiency in mathematics but low interest in STEM comprise more than one-quarter of all 12th graders (ACT, 2011). This pool provides recruitment opportunities to increase amounts of students who select and persist in STEM majors.

Research into the psychological factors influencing educational and career pursuits in science careers credits reported disparities in males and females leading to low recruitment and retention rates to attitudes, confidence and self esteem (Bandura, 1986; Betz & Hackett, 1983, Maple & Stage, 1991). Betz and Hackett found increased independence in females led to increased interest in nontraditional career pursuits such as science related fields. Bandura (1986) posited that females who choose nontraditional career fields have strong beliefs in themselves, go against cultural norms, and are confident regardless of adequate mentoring or support. Their self-esteem is generally higher, and they possess an internal locus of control (Bandura, 1986). Females' self-perception of ability, according to Farmer et al. (1999), is related to career choice, rather than actual ability. Many researchers have sought to identify determinants of science interest and achievement. Family, pedagogical, extracurricular, and social factors also explain student interest and achievement in science (Schoon, 2001; Seymour & Hewitt, 1997). However, strength of interventions depends on capacity to strengthen adolescents' academic motivation and beliefs about ability and capacity to succeed in mathematics and science (Larose, Ratelle, Guay, Senecal, & Harvey, 2006).

Students' attitudes toward mathematics and science are important variables in career selection. Attitudes and perceptions of abilities influence course selection (Benbow & Stanley, 1982). Enrollments in higher mathematics and science courses for males during high school are linked to an increase in mathematics and science development and major selection (Benbow & Minor, 1986; Benbow & Stanley, 1982), whereas, learning experiences in the sciences have had a greater effect on female development and major selection (Krumboltz, 1996). Trusty (2002) echoed previous researchers' conclusions that learning experiences influence major selection more for females than males. However, Trusty (2002) found significant effects for females choosing science and engineering majors occurred when more rigorous mathematics courses were taken, whereas for males, the significant effect occurred only from taking physics.

The supply of highly educated STEM talent diminishes, as does a country's intellectual property, economic growth, and competitive edge, when females choose not to study subjects like mathematics and science (Jordan & Yeomans, 2003; Van Langen & Dekkers, 2005). Researchers have cited various reasons for low female participation in science, explaining why females are underrepresented in STEM careers as well. Brickhouse, Lowery, and Schultz 2000 explained in their discussion of what kind of girls do science:

Girls are alienated by science. Science is masculine, competitive, objective, impersonal—qualities that are at odds with our images of what girls are. Girls are interested in pleasing their teachers and are thus more likely to follow the rules

rather than invent them. Girls prefer to learn in cooperative classrooms that encourage engagement with peers. Although girls may prefer small groups, those classes are dominated by boys who tend to take charge, manipulate the equipment and leave them to play the role of scribe. Girls become women who cannot and do not engage in science. (p. 441)

Greenfield (1996) using National Educational Longitudinal Study of 1988 data reported middle school females have less positive attitudes about science and participate in fewer relevant extracurricular activities than males. Kahle et al. (1993) stated that boys often dominate in science classrooms, particularly during science labs. Baker (1998), in a discussion on equity issues in science education, provided an extensive synopsis of research on the differences in gender as it relates to science education. The American Association of University Women [AAUW] (2008) conducted a study about gender equity in education and announced that the "boys crisis" was a myth. AAUW reported that both females and males were doing better in American schools, compared to 30 years ago, and that gender gaps in academic achievement were generally small and getting smaller. As recently as 2010, however, the AAUW, in the report entitled *Why So Few* (2010), stated women were earning only 20% of all bachelor's degrees in a STEM major, arguing male-female disparities in STEM do in fact exist.

In 1990, the ratio of males to females scoring above 700 on Mathematics SAT was 13:1. In 2010, the ratio was only 3:1 (AAUW, 2010). This increase in the number of females identified as "mathematically gifted" suggests that education can and does make a difference at the highest levels of mathematical achievement. Research profiled



in the 2010 AAUW report indicated that females assess their mathematical abilities lower than males with similar mathematical achievements. Females hold themselves to a higher standard than males in subjects like mathematics, believing that they have to be exceptional to succeed in “male” fields. AAUW posited that fewer females aspire to STEM careers due to lower self-assessment of their mathematics ability. The 2010 AAUW report indicated that emphasis by parents and teachers on the equal achievement by both males and females in mathematics and science encourages females to assess their skills more accurately. The report extends to college and university recruitment of science and engineering female faculty, stating that (a) improved departmental culture promotes the integration of female faculty and (b) implementing mentoring programs and effective work-life policies for all faculty members furthers recruitment and retention (AAUW, 2010).

Student involvement in mathematics and science courses at young ages is crucial for STEM talent and career development. This is especially true for socially disadvantaged groups such as women, ethnic minorities, and economically disadvantaged groups (Callahan & Reis, 1996; Graham, 1994, Hanson, 1994; Trusty, 2002). Hilton and Lee (1988) also noted that female talent loss is found at every educational transition point with the greatest loss occurring at the transition from high school to college. This loss includes both a loss in science and in higher education. Van Langen, Bosker, and Dekkers (2006) suggested that gender achievement gaps in mathematics and science, defined as delayed performance of one sex as compared with the other, is offset by higher female enrollment rates in STEM majors at onset.

Few studies have examined science related career pursuits, a term analogous to STEM career development in the literature, in terms of degree attainment or workforce/career development (Maple & Stage, 1991). Others, focused on major choice, results have included national research studies, e.g., BPS, 2001; Huang et al., 2000; NCES, 2006b; Trusty, 2002, Trusty et al., 2000). Known through NSF findings, considerable numbers of female freshmen have chosen science majors but have not persisted in science related careers or degree attainment (NSF, 2000). Yoo (2005) addressed this in his study focused on the transition from secondary education to college in an effort to examine the factors influencing science related career pursuits of talented females in mathematics and science. Wang and Staver (2001) attempted to fill in this research gap determining factors influencing career development within science. They uncovered positive links between student career aspiration and instructional quality and quantity. However, specific factors in the science classroom (instructional practices, classroom experiences) were not addressed. These factors, according to Yoo (2005), are valuable for the development of intervention strategies for female career pursuits in science.

Females and minorities are even less likely to persist in a STEM field major during college than are male and non-minority students (NSB, 2007). Though representation of females and minorities in STEM fields are increasing, gaps remain (Huang, Taddeuse, Walter, & Samuel, 2000). Researchers have suggested that the supply of female STEM talent at all levels of the career pipeline is to blame. Fewer females and minorities receive bachelor's degrees in STEM fields for two reasons: both groups are

less likely to pick a STEM major initially, and if they do, are less likely to remain in that major (Chen & Weko, 2009; Griffith, 2010). Therefore, interventions aimed at both factors are necessary. Missing from much STEM gender research, but present within career development, are factors that increase retention when dysfunctional career thinking is reduced. Further omissions occur in the literature when looking for interventions that increase female STEM retention. Mentoring, a fully researched vehicle for retention, was employed in this study as the solution to Chen and Weko's (2009) and Griffith's (2010) deficiencies in STEM retention.

#### STEM and Gender in Mentoring

The United States is not producing enough STEM-proficient staff to meet industry need (DOLETA, 2006; U.S. GAO, 2005, 2006; NSF, 2010, 2012). Therefore, research into successful retention strategies that will increase female representation in STEM career was imperative. Though mentoring is seen as a vehicle for first-year retention in the literature, no research exists into its effectiveness with STEM majoring students. Uncovering the interaction between career thinking, decidedness, living-learning communities, female underrepresentation and mentoring enables this intervention to partially fill the STEM talent gap within the U.S. The female mentoring intervention, GEMS, situates the conceptions of Kahle et al (1993), Gati et al. (1999) and Tinto (2003) about gender career decision making and living-learning communities into Campbell & Campbell's (1997) analysis of mentoring's effect on academic performance and retention.

Mentoring as a vehicle for retention exists within education literature. However, studies examining mentoring within STEM are sparse and studies researching female mentoring in STEM are nonexistent. Despite the preponderance of mentoring literature, many limitations exist within it. Jacobi (1991) identified the lack of operational definitions, structure, training and program administration as major limitations. The researcher included research-based practices within the GEMS intervention and proactively addressed existing limitations present in mentoring literature using Campbell and Campbell's (1997) mentoring study as the theoretical underpinning. Though Campbell and Campbell's mentoring study served as the theoretical underpinning, it should be noted that Kahveci et al.'s 2006 study informed some programmatic structure. Mentoring components, which led to increased retention in Kahveci's study, were included during GEMS creation and implementation, are further explained in Chapter 3.

Campbell and Campbell (1997) created a mentor program and evaluated its effects on academic performance and retention. A matched pairs design was used in which 339 undergraduates assigned to mentors were paired with non-mentored students based on gender, ethnicity, GPA, and entering enrollment status. The program was offered to all the freshmen students but mostly targeted underrepresented students. Mentors and mentees were encouraged to meet several times throughout the academic year. Mentors maintained logs of meetings including dates, duration, and content. Besides these meetings, a number of workshops on mentoring styles, campus resources and career network development were also organized for both mentees and mentors to spend time together. Small luncheons such as socials and free tickets to university

theatre events were also organized. The variables taken for measuring the effectiveness of the program were GPA, number of units of credit completed, retention rate, and the duration and number of times of contact between the mentor and student. A series of t-tests were conducted on each of the variables after the first and second semesters and cumulatively after one year. In the results, it was found that mentored students had better academic outcomes and completed .84 more credit units than the control group. The dropout rate for the mentored students was 14.5% compared to 26.3% for the control group. It was also found that more contact between the mentor and mentees resulted in improved GPA and academic performance though academic achievement and retention were unrelated to gender and ethnicity of the mentor, the protégé, or the gender and ethnic match between the two (Campbell & Campbell, 1997). GEMS used loose programmatic design from the 1997 study, paying close attention to program structure and mentor-mentee pairing. Additionally, matched mentor-mentee pairs were guided by Nora and Crisp (2007) who supported clearly defined mentoring interactions and appropriately match pairs that lead to increased mentee retention.

A secondary study, more closely correlated to this study's problem, supported the creation and implementation of the GEMS intervention. Kahveci et al. (2006) started the Program for Women in Science, Engineering, and Mathematics (PWISEM). The objective of this program was to foster participation and improve retention of the first year undergraduate women in SME fields. As part of the program, the women lived in a common residence hall during the entire first year which helped them build an early relationship with their peers and find study partners. All students also took a one-credit

course, Women in Science Colloquium, and as part of the course women scientists from different departments of the university came and described their current research. Apart from these activities, there were a number of other activities organized by the program such as panel discussions, mentoring, advising assistance, research internships, tutoring and field trips (Kahveci et al., 2006). The research design employed in this program was static group pretest-posttest design (Fraenkel & Waulen 2003) in which two already existing groups are used. The control group was the students from Honors General Chemistry (HGC). The HGC group consisted of both males and females. The students were compared in terms of their interest, confidence, and determination in pursuing SME majors, GPAs, intended/declared majors' interest in and understanding of Science and Technology. A questionnaire was developed with insight from two instruments (CIRP 2000, NORC 2004). A pretest and posttest were administered at the beginning and end of the academic year for both the groups. For analysis purposes, three groups were identified (a) PWISEM women, (b) HGC women, and (c) HGC men. One-way ANOVAs were performed for mean differences across groups in the pretest and posttest. Researchers found there was no difference between the three groups in terms of their interest, confidence, and determination in pursuing SME majors and confidence. Also, there was no significant difference in GPA across the three groups. It was also found that at the end of year 38% of HGC women and 13.8% of HGC men changed to non SME majors, whereas only 3.2% of PWISEM students changed to non SME majors (Kahveci et al., 2006).

Though colleges and universities began implementing mentoring programs in the 1980s, and both groups of researchers who guide the mentoring intervention in this study experienced success, no studies examined career thinking and retention effects of STEM-majoring students within a mentoring program (American Association of State Colleges and Universities, 1985; Johnson, 1989). Despite this omission, the magnitude of literature surrounding mentoring suggests its importance and relevance for this study (Hughes, 1988; Lester & Johnson, 1981; Moore & Amey, 1988; Pounds, 1987; Rowe 1989). Mentoring, accepted as sound practice by Cohen, 1995 and as a priority for retention (Girves et al., 2005), assists first-year students transitioning from high school by offering direct career assistance, providing information, problem solving, etc. and provides social-emotional support such as moral support and counseling (Hubard, 2011). Researchers have found that state colleges and universities need to do more to create environments in which females feel comfortable both as students and faculty; women are less satisfied with the academic workplace and are more likely to leave earlier than their male counterparts (Corbett, Hill, & St. Rose, 2010). Eight factors depress the numbers of females in STEM: beliefs about intelligence, stereotypes, self-assessment, spatial skills, the college student experience, university and college faculty, implicit bias, and workplace bias (Epstein, 2010). Female mentoring alleviates some of these factors in fields outside of STEM (Campbell & Campbell, 1997; Kahveci et al., 2006; Pagan & Edwards-Wilson, 2003; Salinitri, 2005; Sorrentino, 2007; Wallace et al., 2000). Though many mentoring programs exist for both men and women, the need for female STEM mentoring was cited as greater because of reduced supply of female students in STEM

and that females change majors to non-STEM fields at a greater rate than males. Furthermore, though the representation of women among those receiving bachelor's degrees in all fields from United States universities exceeds 57%, less than 20 % of the degrees in engineering were awarded to women (Beede et al, 2011). Among these, the numbers of women opting for non-STEM fields or careers are higher in comparison to men.

Researchers have addressed mentoring as a means of promoting student success, increased grade point average and positive decisions to persist in college (Campbell & Campbell, 1997; Kahveci et al., 2006; Pagan & Edwards-Wilson, 2003; Salinitri, 2005; Sorrentino, 2007; Wallace et al., 2000). Within higher education, mentees achieve better academic performance (Campbell & Campbell, 1997) and social integration (Allen, McManus, & Russell, 1999), and mentors benefit from personal relationships with students (Eby & Lockwood, 2005) and the satisfaction associated with being a mentor (Treston, 1999). Universities profit from increased student retention through tuition dollars (Campbell & Campbell, 1997).

One of the stronger cases on the positive impact of mentoring on student performance was presented by Rodger & Tremblay (2003). Researchers found students who participated in the mentoring program and remained engaged in the intervention over a two-year period had significantly higher grades than those students who received no active intervention (non-mentored students).

Similar outcomes can be expected within female STEM-majoring students. Evidence suggests that women and minorities respond best in more collaborative learning



experiences, which include working with mentors (Green, Evans, & King, 2001). It is also clear that mentoring relationships are important to the professional growth and development of both women and men (Gardiner, Tiggemann, Kearns, & Marshall, 2007; Sullivan-Brown 2002; Enomoto, Gardiner, & Grogan, 2002; Kochan 2002). However, for these types of developmental interactions to work effectively, appropriate opportunities for mentoring must exist. In academia, women continue to hold fewer positions at higher rank than men in science and engineering: 42% hold the rank of instructor or assistant professor, 34% hold the rank of associate professor, and 19% hold the rank of professor (Burrelli, 2008, NSF 09-305 2009; Trower & Chait, 2002). Furthermore, women with degrees in science and engineering make up more than half of the part-time academic workforce, and they are typically paid less than men for the same job--36% less when comparing salaries at the bachelor's level and 21% less when comparing them at the doctorate level (NSB, 2010). Lack of female role models at various levels of the STEM career pipeline exacerbates feelings of STEM being male-centered by female students (AAUW, 2010). The reasons underlying the gender imbalance in the salaries, higher ranks, and leadership positions include a lack of networking opportunities, lack of role models, and slow research progress for women (Gardiner et al. 2007).

In spite of the vast amount of research done in mentoring there is absence of a widely accepted operational definition of mentoring (Jacobi 1991, Dickey, 1996; Johnson, 1989; Miller, 2002; Rodriguez 1995; Zimmerman and Danette, 2007). Fifteen different definitions of mentoring were identified by Jacobi (1991) derived from the field

of education, psychology and business. Jacobi (1991) cited lack of a common mentoring definition within the literature as a major concern regarding mentoring as it applies to academic success of students. Crisp and Cruz (2009) echoed concerns regarding operational definitions being absent, vague or not specific to the population of interest and cited this omission as a major shortfall of qualitative and quantitative mentoring studies. Also stated as a limitation in their analysis of mentoring literature from 1990-2007 was the lack of theoretically based measurement tools and use of “homegrown surveys” (Lloyd & Bristol, 2006; Sorrentino, 2007; Zimmerman & Danette, 2007). Mentoring program outcomes were apparent in the literature; however, mentoring styles have rarely been taken into consideration and little research into unobtrusive data, such as measures of spent time or frequency of meetings with a mentor, exist. One reason for this gap in literature may be that face-to-face mentoring restricts action researchers can take in collecting information on unobtrusive parameters, as they often interfere with the mentoring process itself, e.g., the presence of a researcher, the use of recording instruments. In contrast, online mentoring provides an opportunity to collect such data without disruptions (Leidenfrost, Strassnig, Schabmann, Spiel, & Carbon, 2011), but little research exists in regard to online versus face-to-face mentoring effectiveness in female retention. Though research into mentoring abound, current literature lacks a well-developed, tested and validated theory conceptualizing mentoring.

Nora and Crisp (2007) identified four major domains or latent variables comprising the mentoring concept. These were validated using a community college population (Crisp & Cruz, 2009) and also for undergraduate students attending a

Hispanic Serving Institution (Crisp, 2008). The four latent variables as taken from Nora and Crisp's 2007 paper are: (a) psychological and emotional support, (b) support for setting goals and choosing a career path, (c) academic subject knowledge support aimed at advancing a student's knowledge relevant to their chosen field, and (d) specification of a role model. The first construct, psychological/emotional support, encompasses a sense of listening, providing moral support, identifying problems and providing encouragement. The second domain, goal setting and career paths, focuses on the establishment of a supportive relationship in which there is mutual understanding and a link between the student and the mentor. It represents the underlying notion that mentoring includes an assessment of the student's strengths/weaknesses, and abilities and assistance with setting academic/career goals and decision making (Nora & Crisp, 2007). The third construct, academic subject knowledge support, centers on the acquisition of necessary skills and knowledge, on educating, evaluating, and challenging the mentee academically (Nora & Crisp 2007). Additionally, focus is paid to employing tutoring skills and targeting subject learning in contrast to mentoring that focuses on life learning (Miller, 2002) and on establishing a teaching-learning process (Roberts, 2000). The fourth domain, the role model, concentrates on the ability of the mentee to learn from the mentor's present and past actions and achievements/ failures (Nora & Crisp 2007). In the Literature Review on Mentoring done by Jacobi 1991, three components of Mentoring relationship were identified: (a) emotional and psychological support, (b) direct assistance with professional and career development and (c) role modeling. These

components are similar to the four constructs comprising mentoring identified by Nora and Crisp (2007).

Mentor-mentee relationships and matching are critical to mentoring success and vary in length, circumstance, and foundation based on the motivation of the mentoring model or programmatic need. Luna and Cullen 1995 identified six critical types of mentoring relationships: (a) formal mentoring relationships are matched, managed, approved and scheduled by an educational institution (Chao et al., 1992); (b) informal mentoring relationships are not structured, managed, or formally recognized by the institution (Chao et al. 1992); (c) long-term relationships last for more than one year; (d) short lived duration of the relationships could be one semester or as short as one meeting (e) Planned relationships between mentor and mentee are planned and scheduled by a third party or reoccurring bases; (f) spontaneous unplanned and may be formed on the spur of the moment.

Mentoring literature proposes that relationships develop through a series of stages. Results of Kram and Isabella's (1985) study, though limited in terms of external validity and possible relevance to students, indicated four phases of mentoring relationships. The first stage is the initiation stage which lasts between six and 12 months. The initiation stage is the time when the relationship between the mentor and mentee is started. The next stage is the cultivation stage which is defined as the time in which the range of mentoring functions expands and lasts between two and five years. The third stage is the separation, characterized by psychological or structural changes in the organizational context. In this stage, the relationship between mentor and mentee is

altered, and the mentee gains independence. The fourth and final stage is the definition stage where the relationship evolves into a new and significantly different relationship. This is also the stage in which the relationship ends (Kram, 1983). Many researchers have observed mentor-mentee matching based on gender or ethnic backgrounds (Johnson, 1989; Meznick, McGrath, & Garcia, 1989; Oestereich, 1987).

Though varying definitions, conceptual constructs and structure exist within the literature, researchers have agreed on the following:

1. Mentoring relationships are focused on the growth and accomplishment of an individual and include several forms of assistance (Chao et al., 1992; Cullen & Luna, 1993; Ehrich et al., 2004; Haring, 1999; Johnson & Nelson, 1999)
2. The mentoring experience may include broad forms of support, including assistance with professional and career development (Brown, 1999; Campbell & Campbell, 1997; Chao et al., 1992; Davidson & Foster-Johnson, 2001; Kram & Isabella, 1985)
3. Role modeling (Brown, 1999)
4. Mentoring relationships are personal and reciprocal (Davidson & Foster-Johnson, 2001; Green & Bauer, 1995; Kram & Isabella 1985; Healy & Welchert, 1990; Hunt & Michael, 1983; Johnson, 1996) and
5. Psychological support (Chao et al., 1992; Cullen & Luna, 1993; Davidson & Foster-Johnson, 2001; Green & Bauer, 1995; Kram & Isabella 1985; Levinson et al., 1978).

The GEMS model used the first four constructs during creation and referred students in need of psychological support, as determined by Career Thoughts Inventory and Career Decision Scale, or mentee/mentor request, to the university counseling center.

Further exemplifying the need for mentoring when filling the STEM talent and career development gap, Green and King (2001) have suggested that females and minorities respond best in more collaborative learning experiences which include working with mentors. It is also clear that mentoring relationships are important to retention, professional growth and development of females (Gardiner et al., 2007; Enomoto et al., 2002; Kochan, 2001; Sullivan-Brown 2002). Therefore, the GEMS intervention, designed to be formal and structured, addresses glaring limitations and gaps in the literature and attempts to solve part of the STEM talent and career development problem by reducing dysfunctional career thinking through mentoring within a living-learning community.

#### Living-Learning Communities (LLCs)

U.S. STEM talent deficits frame the need for career focused interventions specifically designed to address female underrepresentation in STEM. Tinto's (2003) research into living-learning community effectiveness in diminishing attrition rates by fostering an environment that enables gender barriers, such as attitudes, perceptions and self esteem, helps to fill the retention gap in STEM literature. Understanding the interplay between career thinking, decidedness, living-learning communities, female underrepresentation, and mentoring enables this intervention to partially fill the STEM

talent gap within the U.S. The female mentoring intervention, GEMS, situates the conceptions of Campbell & Campbell (1997), Kahle et al. (1993) and Gati et al. (1999) about mentoring, gender, and career decision making into Tinto's (2003) research on living-learning community success. Tinto (2003) argued that retention success is experienced when universities employ interventions within living-learning communities. Smaller-living-learning communities (LLC) foster an increased sense of community, a need expressed in female mentoring research. Literature on factors that influence persistence and graduation rates of colleges abound since 1990. Researchers attribute increased retention of students to increased campus involvement garnered through faculty and peer interaction participation in student activities and organizations and living in residence halls. These students are more satisfied, more successful, and persist at higher levels than are students not involved in similar activities (Astin, 1975, 1995; Kuhn et al, 1991; Pascarella, 1980, 1982; Pascarella & Terenzini, 1991; Noel et al., 1985). However, though research has shown that these factors enhance the college experience for many traditional-aged, full-time, residential students, more FTIC students enrolling in metropolitan colleges and universities do not fit this profile and are unlikely to initiate involvement in campus experiences on their own.

As described by Gablenick and her colleagues in their 1990 text, many learning communities do more than co-register students around a topic. They change the manner in which students experience the curriculum and the way they are taught. Faculty often reorganize syllabi and classrooms to promote shared, collaborative learning experiences among students. This form of classroom organization requires students to work together

in some form of collaborative groups and to become active, indeed responsible, for the learning of both group and classroom peers. In this way, students are asked to share not only the experience of the curriculum but also of learning within the curriculum (Tinto, 2003).

Learning communities, like any other intervention, have limits to their effectiveness. Some students do not like learning with others, and some faculty find collaborating with other faculty and staff difficult. Nevertheless, like other efforts to enhance student involvement in learning, such as cooperative learning and classroom assessment, there is ample evidence to support that LLC's enhance student learning and persistence and enrich faculty professional lives (Cross, 1998; Tinto, 2003). Within this study, GEMS was specifically and systematically embedded within the STEM-LLC to do both: (a) enhance student learning and persistence and (b) enrich faculty professional lives. Supporting the creation of LLCs was the desire by STEM-LLC faculty and staff for a mechanism to increase socialization activities of female first-year students, and GEMS social components were created in response to this need. Creating a fully functioning social and academic community allowing females to quell career decision-making anxiety, gain academic support, and remove barriers to STEM retention were goals of GEMS and made up the rationale behind embedding GEMS within the STEM-LLC.



## Summary

In summary, researchers have shown that though career development, mentoring, living-learning communities and female underrepresentation in STEM constitute larger literature bases in academic research, the interplay between these topics within STEM retention is sparse or nonexistent. It is evident from research reviewed that retention and academic success are derived from each subtopic individually; thus, success within the intervention, GEMS, and the STEM-LLC should be mirrored. Lack of STEM talent and career development research coupled with needs to increase female presence within STEM drove this study. Removal of barriers to STEM persistence, such as addressing female attitudes and beliefs about their ability to be successful in STEM, mentoring as a vehicle for academic success and retention and career theory's role in reducing dysfunctional career thoughts framed the creation and implementation of the GEMS intervention. In Chapter 3, the methods used to determine the success mentoring had on the reduction of dysfunctional career thinking with female first-year STEM-majoring students are presented. These include the experimental design, instruments, and analysis procedures as well as a complete description of the GEMS model including creation and implementation of pilot and intervention years. Also addressed in Chapter 3 are the assumptions and limitations which framed this study. Brief pilot retention data was presented to provide background for the study.

## CHAPTER 3 METHODOLOGY

### Introduction

This study sought to partially fill the STEM talent and career development gaps in retention research present at the undergraduate level through a female mentoring intervention designed to gauge levels of dysfunctional career thinking within a STEM-LLC. Determining practices that increase retention of females, an underrepresented population in STEM, through career development was not present in the literature but successes of mentoring, living-learning communities and career development as separate interventions were supported by academic literature. In this chapter, the experimental design employed during data collection is presented. Following the design, a description of the instruments and analysis procedures are provided along with an explanation of the assumptions and limitations of the study. The chapter is concluded with the complete description of the creation and implementation of the female mentoring intervention, GEMS.

### Research Design

Causal comparative design using repeated measures MANOVAs and canonical correlations measured the influence of the GEMS mentoring program on career readiness and career decidedness among first-year STEM-majoring students defined the research design used in this study. The research study was conducted over a nine-month period with quantitative data derived from valid and reliable career assessments collected at

specific time markers. Repeated measures MANOVAs showed mentoring intervention effects on career thinking and decidedness for the first two research questions, and canonical correlations analyzed the effect of female participation on career readiness and decidedness. Repeated measures multivariate analysis of variance was an appropriate research method, as several dependent variables (CTI and CDS scores) were analyzed over three periods in time, and gender and time were used as independent variables. Running repeated measures MANOVAs rather than individual univariate tests reduced the possibility of committing a type 1 error (Tabachnick & Fidell, 2007). Similarly, in an effort to reduce Type 1 errors and because multiple dependent variables (CTI and CDS scores) and multiple independent variables (participation points for mentor meetings, socials, and networking events) were included, canonical correlations were employed to determine relationships rather than regression analysis or correlations. Research activity was initiated only after the Institutional Review Board of the University of Central Florida had reviewed and approved the study (Appendix A).

### Setting

The study was conducted within a large metropolitan university in the southeastern United States. About 60,000 undergraduate students, including a large population of minorities and females, populations traditionally underrepresented in STEM, attend the university. Of the university's undergraduate STEM majors, 30.06% were underrepresented minorities and 37.13% were females (EXCEL Retention Numbers, Fall 2012 Report, Institutional Research Office, University of Central Florida).

The STEM-LLC student population for the 2011/2012 school year was comprised of 36.32% minorities and 37.37% women. *Diverse Issues in Higher Education* (2006) ranked the university within the top 25 around the nation in graduation of Hispanic and African-American baccalaureates in engineering.

The surrounding city is diverse with rapidly changing demographics. According to a Brookings Institute report (Berube, 2009), as of 2009, the city ranked 17th among the large melting-pot metropolitan areas (having more than one minority group overrepresented) in the United States. The city was in the top three metropolitan areas with the fastest growing African-American and Asian populations and among the highest in Hispanic growth rate. The largest local school district in the region regularly provides the university with FTIC students and, in turn, the university produces teachers that are hired by the district. In 2008, the school district was in the top 15 largest districts in the nation with 174,923 students and 22,176 personnel (Orange County School Enrollment Projection Tool (OCSEPT) 2008). The majority of the student population is of minority status: 31% are Hispanic, 27% are African American, 4% are Asian, and 3% are multicultural or American Indian/Alaskan Native.

Improving retention, graduation rates, and success of STEM-majoring undergraduate students exist as goals of the NSF funded STEM-LLC used in the present study. Annually, STEM-LLC admits about 200 first time in college (FTICs) STEM-majoring students whose mathematics SAT scores are in the second and third quartile (550-650) among STEM FTIC's at the university. Students must first obtain admission to the university to be eligible to apply for the STEM-LLC. The STEM-LLC

aggressively recruits incoming first year students through direct mailing, emails to students and parents, university open houses, and guidance counselors at state high schools. Current retention practices within the STEM-LLC include enhanced educational opportunities, i.e., common mathematics courses, a staffed tutoring center focused on mathematics and science courses, designated graduate teaching assistants for each who monitors students' performance, consistent advising from a first-year advisor and the pertinent STEM college advisors, paid sophomore undergraduate research experiences, and social activities. The STEM-LLC's self-sustaining and university institutionalized model has increased STEM-graduation rates above university and national levels and, as a result, has attracted industry funding to support sophomore research experiences.

The STEM-LLC recruited 948 students in its first five years (2006-2010). Of the total students, 68.46% were male and 31.54% were female. During this time, the STEM-LLC retained students in STEM at an 18.02% higher rate than the control group of STEM-majoring students at the university. STEM-LLC males were retained in STEM-majors at an 18.53% higher rate than control group males, and STEM-LLC females were retained in STEM-majors at a 15.12% higher rate than control group females. Reduction of female underrepresentation within STEM-majors as compared to men has not been realized despite successes within female recruitment and retention by STEM-LLC. Looking at the 2010-2011 school year, only 67.97% males and 53.92% females were retained, a 14.05% difference between the genders. Additionally, of the 57 females who joined STEM-LLC in 2009, 17 (30%) left their STEM-major in the first year, lower than the national average of 40% but still too high to please academicians and politicians.

### Research Questions and Hypotheses

Investigation into the effect of mentoring on dysfunctional career thinking and career decidedness, and subsequent retention, of first year STEM-majoring females formed the foundation for this research study. The following four research questions were used to investigate the effect mentoring plays on career thinking, readiness, and decidedness:

1. What effect did the GEMS (Girls Excelling in Mathematics and Science) mentoring program have on career readiness as measured by the Career Thoughts Inventory?
2. What effect did the GEMS (Girls Excelling in Mathematics and Science) mentoring program have on career decidedness as measured by the Career Decision Scale?
3. What effect did participation in the GEMS (Girls Excelling in Mathematics and Science) program have on career readiness as measured by participation levels and the Career Thoughts Inventory?
4. What effect did participation in the GEMS (Girls Excelling in Mathematics and Science) program have on career decidedness as measured by participation levels and the Career Decision Scale?

### Null Hypotheses

1. No differences exist in career readiness, as measured by the CTI, between the GEMS and non-GEMS study participants.

2. No differences exist in career decidedness, as measured by the CDS, between the GEMS and non-GEMS study participants.
3. No relationship exists between GEMS participation and changes on the CTI.
4. No relationship exists between GEMS participation and changes on the CDS.

### Variables

Two research designs were used to answer the four research questions. The first two questions were analyzed using repeated measures MANOVA. The independent variables for the first two research questions were gender, date of test administration and treatment versus comparison groups. The dependent variables were the assessment scores. Two canonical correlations were used to analyze the Research Questions 3 and 4. The dependent variables were the change scores between test administration I (August) and III (April) for both assessments with mentee participation points as the independent variable.

### Population

The population for the research study was the STEM-LLC which consisted of 201 males and females. A total of 75 females comprised the intervention group. All females co-participated in GEMS and STEM-LLC, and all 126 males participated only in the STEM-LLC. Volunteers from a convenience sample of female STEM-LLC students were recruited as mentees. Per Institutional Review Board (IRB) process, signed consent

forms were collected. All females were mentees within the mentoring intervention mentored by upper-level STEM-LLC students.

### Data Collection

Data for this study were quantitative and comprised of assessment scores and participation rates. Assessments used were the Career Thoughts Inventory (CTI) and Career Decision Scale (CDS) which were administered in August, December, and April. Participation was defined by attendance and was tracked by the GEMS coordinator at every event using sign-in sheets with points assigned for attendance. CTI and CDS assessments were hand-scored by training research assistants and entered into a STEM-LLC spreadsheet created by the researcher. Data were validated by the researcher and an external data-validator who checked all completed assessments. Data validation included rescoring of hard copy assessments, and spreadsheet data entry check of STEM-LLC for each event (August, December, April); if an error was found, the researcher determined if it was a data entry error by comparing student scores to prior spreadsheets and rescoring the hard copy assessment. Once the STEM-LLC database was complete and error free, it was imported into SPSS, and subsequent statistical analyses occurred.

### Instruments

The GEMS female mentoring program was designed to impact career development by engaging mentees socially and academically using social events, mentor-mentee meetings, networking events and tutoring. Assessments to gauge career thinking



and decidedness, Career Thoughts Inventory (CTI) and Career Decision Scale (CTI), were administered three times during the freshman year, August, December, and April.

### *Career Thoughts Inventory (CTI)*

The Career Thoughts Inventory (CTI) is a theory-based assessment and intervention resource intended to improve the quality of career decisions made by adults, college students, high school students, and the quality of career services delivered to these individuals. It is a self-administered, objectively scored measure of dysfunctional thinking in career problem solving and decision making (Sampson et al., 1996; 1999).

The assessment contains 48 items with a four-point rating scale. The assessment results a CTI total score, which is an indicator of negative thinking in career decision-making or problem solving. In addition to this score, the assessment rates each participant on three construct scales:

1. Decision Making Confusion (DMC): This scale reflects an inability to initiate or sustain the decision-making process as a result of disabling emotions or a lack of understanding about the decision-making process.
2. Commitment Anxiety (CA): This scale reflects an inability to make a commitment to a specific career choice, accompanied by generalized anxiety about the outcome of the decision-making process that perpetuates the indecision.
3. External Conflict (EC): This scale reflects an inability to balance the importance of one's own self-perceptions with the importance of input from

significant others, resulting in a reluctance to assume responsibility for decision making.

### *CTI Psychometrics*

Item development began with the selection of cognitive information processing (Sampson et al, 1999) and cognitive therapy (Beck, 1976). Items were developed within the following CIP content dimensions: self -knowledge, occupational knowledge, analysis, synthesis, valuing, execution, and executive processing. A total of 248 items were created. Through revision and deletion, 195 items remained in the pool. A non-biased panel identified and corrected items related to ethnicity, gender, cultural appropriateness, and reading level. A development study (n = 320) reduced the item pool to 80 with all items at a 6.4 reading level. Two additional development studies were run yielding the final 48-item instrument. Development studies on college students (n = 595) yielded M = 47.01 SD = 20.89 at a  $\alpha = .96$  for the CTI total (48 items); M = 10.72 SD = 7.39 and  $\alpha = .94$  Decision Making Confusion (14 items); M = 12.92 SD = 5.36 and  $\alpha = .88$  Commitment anxiety (10 items) and M = 3.32 SD = 2.15 and  $\alpha = .77$  for external conflict (5 items) (Sampson, Peterson, Lenz, Reardon, Saunders, 1994)..

Internal consistency of CTI total score and construct scales were determined by coefficient alphas for each normative group. CTI total score ( $\alpha = .93-.97$ ) DMC ( $\alpha = .90-.94$ ) CA ( $\alpha = .79-.91$ ) and EC ( $\alpha = .74-.81$ ). Researchers have suggested the low number of items in EC contributed to lower reliability. Stability, the extent to which an individual obtains the same score on two different occasions, was measured using a

sample of 48 individuals. CTI total score stability was  $r = .86$ , high,  $DMC = .82$ ,  $CA = .79$  and  $EC = .74$ . Correlations for college sample were the higher than high school population (Sampson et al., 1994).

The assessment tool demonstrated validity in the following areas:

1. **Content Validity:** The congruence of CTI items, CIP content dimensions, and construct scales with the theoretical basis of the instrument.
2. **Construct Validity:** The extent to which clusters of empirically associated items are conceptually consistent with the theory can be identified and reproduced across populations.
3. **Convergent Validity:** The extent to which the CTI total score and construct scales correlate with other measures of similar constructs in a theoretically consistent direction.
4. **Criterion-Related Validity:** The extent to which the CTI accurately disseminates between persons seeking career services and persons not seeking career services (Sampson et al., 1994)

CTI total intercorrelations among college students are as follows: CTI total and  $DMC r = .92$ , compared to  $CA r = .86$  and  $EC r = .80$ . This suggests that a predisposition to dysfunctional thinking strongly influences additional aspects of dysfunctional thinking such as commitment anxiety (Sampson et al., 1994).

Convergent validity is the extent to which CTI total score and construct scale scores correlate with other similar measures in a theoretically consistent direction.

Measures used in the study for correlation were: my vocational situation, career decision scale, career decision profile, revised NEO Personality Inventory and evidence of convergent validity: CTI total and MVS  $r = .41-.69$ , CTI total and CDS  $r = -.61-.70$ , CTI total and CDP  $r = .43-.58$ , and CTI total and NEO  $r = .32-.54$ (Sampson et al., 1994).

Criterion related validity measured the extent that the CTI accurately distinguished between persons seeking and not seeking career intervention. Researchers used a MANOVA to show significant differences between college students seeking and not seeking intervention: Hotellings  $T^2 = .77$ ,  $F(48) = 1.83$   $p < .01$ . Post hoc comparisons revealed significant differences in those receiving and not receiving interventions. No F ratio was negative, indicating those needing or receiving intervention was always higher than those not receiving intervention. Therefore, researchers concluded that evidence of criterion related validity existed and allowed discrimination between those receiving and not receiving intervention (Sampson et al., 1994).

Finally, CTI has great utility. The assessment is quick to administer. It can be scored rapidly and is easy to interpret. It is low cost and integrates into service delivery with ease (Sampson et al., 1994).

Researchers recommend future research areas for CTI use in: career thinking, interests, values, career choice anxiety, academic self-efficacy, decision anxiety, and more. Therefore, use of this assessment was appropriate for this study (Sampson et al., 1994).

### Career Thoughts Inventory Use Within GEMS

The Career Thoughts Inventory subscales were used to determine levels of decision making confusion, commitment anxiety and external conflict for STEM-LLC students. Repeated measures MANOVAs determined intervention effect over time on reductions or increases in subscales for both treatment and comparison groups.

### Career Decision Scale (CDS)

The Career Decision Scale (CDS) provides an estimate of career indecision and its antecedents as well as an outcome measure to determine the effects of relevant interventions. The assessment has 19 items, with students indicating how closely each statement describes their feelings as they relate to educational and occupational plans on a scale of 1-4. The certainty scale (items 1 and 2) measures the degree of certainty a student feels about his or her decision about a college major and career. The indecision scale (items 3-18) provides a measure of career indecision. Item 19 is open-ended, allowing the student to clarify or provide additional information about his or her career decision making (Osipow & Winer, 1996).

### CDS Psychometrics

Item selection was compiled from original CDS version (Osipow, Carney, Winer, Yanico, & Koschier, 1987). Two studies have reported test-retest correlations of .90 and .82 for college students. Slanley, Palko-Nonemaker, and Alexander (1981) examined test-retest reliability yielding a correlation of .70. Six different studies conducted

between 1976 and 1985 found factors served as good predictors of career decision making and identified those individuals who would benefit from career counseling. A correlation to ACDM, the assessment of career decision making (Buck & Daniels, 1985) yielded a correlation  $r = -.265$ ,  $p = .004$ . Therefore, researchers concluded that the CDS has acceptable levels of test-retest reliability and norms for college students. The validity is strong; the instrument can differentiate between career decision and indecision.

#### Career Decision Scale Use within GEMS

The Career Decision Scale subscales were used to determine levels of decidedness and indecision for STEM-LLC students. Repeated measures MANOVAs determined an intervention effect over time on reductions or increases in subscales for both treatment and comparison groups.

#### *Administration of Instruments*

Assessments were administered by STEM-LLC faculty in hard copy during students' Calculus or Pre-Calculus classes the first week of fall semester classes (August), the week after thanksgiving break (November) and two weeks before the end of the spring semester (April) during the 2011/2012 school year. The STEM-LLC was centered and co-enrolled around mathematics coursework. Therefore, all members of the STM-LLC were tested and enrolled in either Calculus or Pre-Calculus during both Fall and Spring semesters of their first year. All members of the population, treatment and comparison, took the assessment the same week. Students who were absent completed

the assessment when they returned to class. Faculty were trained on assessment delivery by STEM-LLC Co-Principal Investigator and the researcher using the assessment manual as the guide for training. Faculty were given manuals for additional information on delivery and assessment usage. Completed assessments were hand-delivered to the researcher for scoring and data entry by the Co-Principal Investigator of the STEM-LLC. The researcher and GEMS coordinator tracked student assessments and made every effort, within IRB guidelines, to recover missing assessments. Various reasons for missing assessment included: change of major, withdrawal from university, absenteeism, and student desire to not complete the assessment. Assessments were first scored by the research assistant, checked by researcher, with data validation being performed by an external graduate assistant. Data validation occurred prior to import of data into SPSS and before statistical analyses were conducted.

### Statistical Analysis

Though treatment group participants were coached within mentor groups, comparison group participants were not. Therefore, multilevel analysis techniques using hierarchical linear modeling (HLM) were not employed (Raudenbush & Bryk, 2002). Rather, repeated measure MANOVAs were used to measure career thinking and decidedness over time for both the treatment and comparison groups. Repeated-measures MANOVAs assumed equally spaced time intervals, normal distribution, and were robust against violations of normality (Tabachnick & Fidell, 2007). Little's (1988) Missing at

Random test was completed on the dataset, and missing data were generated by SPSS.

See Chapter 4 for complete discussion.

Two statistical designs were employed to answer the four research questions. Research Questions 1 and 2 used repeated measures MANOVAs to determine the effect of mentoring on career readiness and career decidedness. Variance was determined through a 2 (gender,) x 3 (time administered, within August, December, April) design. The dependent variables used were assessment scores for the CTI and CDS. Normal distribution of data was checked before nested design analysis was conducted.

The second design, canonical correlations, was used for Research Questions 3 and 4 to analyze the relationship for each student between two sets of variables, subscale score and participation (Tabachnick & Fidell, 2007). Canonical correlations were employed to determine if and how the two sets, subscales scores and participation points, related to each other (Tabachnick & Fidell, 2007). In canonical correlations, multiple dependent and independent variables exist, as within this study. The dependent variables are the change scores of CTI and CDS from test administration one to three run against the independent variables and participation points corresponding to number and type of GEMS events attended for each mentee. Analysis of the canonical correlations revealed if females who attended more events had reduced dysfunctional career thinking. Data was determined to be linear, normal and homoscedastic for canonical correlation analysis. Missing data was handled and no outliers were removed based on recommendations by Tabachnick & Fidell (2007).



### Assumptions and Limitations

A limitation of this study resulted from the lack of a truly experimental research design. The sample was not fully randomized and a comparison group of males within the STEM-LLC, rather than control, was used. Participants in the intervention, GEMS, were selected for admission into STEM-LLC and, based on gender and election to participate, were in GEMS.

STEM-LLC outreach strategies may exist as a barrier to entry. Students from private schools and high schools, whose guidance counselors were not part of the STEM-LLC media campaign, may not have been aware of the STEM-LLC. Therefore, participating male and female students were predominately from public secondary schools. Because undergraduate retention is viewed as persistence of STEM majors from fall semester to spring semester, retention rates from first year to sophomore year were not available until after the study was completed.

It was assumed that the reduction in career thinking was due to the GEMS intervention, as no other factor in the STEM-LLC changed. Additional limitations were related to why both males and females completed the career assessments as students in the STEM-LLC. Participants may not have been a true representation of the population and were perhaps motivated to participate in activities that were viewed as helping in their track to graduation. The culture of the STEM-LLC may also have contributed to the response rate, or lack thereof. This study did not address a key factor identified by females as a barrier to completion, less family friendly flexibility within STEM careers or

outside factors, such as class capacity, which frustrates females and may lead to decreased retention (AAUW, 2010).

### GEMS Mentoring Program Rationale

The remainder of this chapter elaborates on why mentoring coupled with career development practices were relevant to this study. Additionally, a complete description of the GEMS program including creation and implementation follows.

#### *Characteristics of Undergraduates Who Declare a STEM Major*

The rationale for implementing GEMS as a female-only mentoring program was attributed to BPSLS (96:01). and the STEM-SLL 2009 attrition rate Using BPSLS (96:01) as the most comprehensive dataset, percentages of males declaring STEM majors were higher than those of women (33% vs. 14%). The statistic is more pronounced in mainstream STEM fields such as mathematics, engineering/engineering technologies and computer/information sciences. A total of 47% of Asian/Pacific Islander students entered STEM majors, as compared to 19 to 23% of students in each of the other racial/ethnic groups. No measurable differences were found among white, black, and Hispanic students. The statistic is mirrored in the 2006 American Council on Education study finding that black and Hispanic students entering four-year institutions majored in STEM fields at rates similar to those of white students (Anderson & Kim, 2006).

The percentage of students declaring a STEM major was shown through BPSLS (96:01) to be higher for younger (age 19 or younger) and dependent students than for

older (age 24 or older) and independent students. When compared to their U.S.-born counterparts, a higher percentage of foreign students entered STEM fields overall (34% vs. 22%), and computer/information sciences in particular (16% vs. 6%). A higher percentage of students from families with income in the top 25%, or whose parents had at least some college education entered the natural sciences (including the biological/agricultural sciences and physical sciences) entered STEM than students whose family income fell in the bottom 25% or whose parents had a high school education or less entered STEM (BPSLS, 96:01).

The following academic indicators were associated with STEM entrance: The percentage of students entering STEM fields was higher among students who took Trigonometry, Pre-Calculus, or Calculus in high school; earned a grade point average of 3.0 on a 4.0 scale or higher; or had college entrance examination scores in the highest quarter (BPSLS, 96:01). Most treatment and comparison group students declaring STEM majors had similar demographic and academic characteristics.

#### *STEM Persistence*

Of the students declaring a STEM major during their first year of enrollment, 37% completed a degree or certificate in a STEM major (STEM “completers”) over the following six years. Seven percent of students maintained enrollment in a STEM major, but had not completed a degree in a STEM major (STEM “persisters”), while 55% left STEM fields (STEM “leavers”) by either switching to a non-STEM field (27%) or leaving postsecondary education without earning any credential (28%). A total of 35% of

all STEM entrants had attained a bachelor's degree by 2001. Among these bachelor's degree recipients, 27% earned a degree in a STEM field and eight percent did so in a non-STEM field. The bachelor's degree attainment rate in a STEM field was highest for students who entered physical sciences (47%) and lowest for those who entered computer/information sciences (12%).

Students at the university housing the STEM-LLC and GEMS intervention mirrored the previously stated characteristics. Therefore, the researcher made every attempt to ensure GEMS mentors were representative of the same characteristics, having a variety of STEM majors, races, and ethnicities, mathematics preparedness, and other demographic factors represented. Nora and Crisp (2007) recommended forging common bonds between mentors and mentees at onset.

Using Nora and Crisp's 2007 study in an effort to increase STEM persistence, GEMS provided psychological and emotional support through mentors to their mentees during face-to-face meetings, phone calls, and social events. The second construct, support for setting goals and choosing a career path, was addressed through increased academic advising during networking events and from mentors and faculty. Mentors provided support to mentees for setting goals, but these goals were generally short- not long-term goals that influenced the mentees' future careers. The third construct, academic subject knowledge and support, was fulfilled in part by mentors, academic advisor, and tutors specific to the GEMS program. Support activities were prescribed at various points in the semester and when requested by the mentee. The fourth construct, role model, was delivered via networking events. In the networking events, female

professors and industry leaders were invited to share their life success stories, provide advice, and encourage mentees.

### The Learning Community: STEM-LLC

Improving retention, graduation rates, and success of STEM-majoring undergraduate students was the goal of STEM-LLC. To this end, the university leveraged its 2006 National Science Foundation STEP grant award to create a STEM-focused living-learning community. Annually, the STEM-LLC admits 200 first-time-in-college (FTICs) STEM-majoring students whose mathematics SAT scores are in the second and third quartiles (550-650) among STEM FTICs at UCF. In order to be eligible for STEM-LLC students must first obtain admission to the university. The STEM-LLC aggressively recruits incoming first year students through direct mailing, e-mail to students and parents, UCF open houses, and guidance counselors at state high schools. Current retention practices within STEM-LLC include enhanced educational opportunities as follow: (a) common mathematics courses; (b) a Tutoring Center focused on mathematics and science courses, staffed with designated graduate teaching assistants for each mathematics class who monitor students' performance; (c) consistent advising from a first year advisor, and the pertinent STEM college advisors paid sophomore undergraduate research experiences; (d) and social activities. The STEM-LLC's self-sustaining and university institutionalized model came about due to high academic successes, increased graduation rates above university and national levels, and ability to attract outside funding for sophomore research experiences.

STEM-LLC recruited 948 students in its first five years (2006-2010). Of this total, 68.46% were male, and 31.54% were female. During this time, STEM-LLC was able to retain students in STEM at an 18.02% higher rate than a control group of STEM-majoring students at the university. STEM-LLC males were retained in STEM-majors at an 18.53% higher rate than control group males, and STEM-LLC females were retained in STEM-majors at a 15.12% higher rate than control group females. The eradication of female underrepresentation within STEM-majors as compared to men has not been realized despite success of female recruitment and retention through STEM-LLC programming. In reviewing data for the 2010-2011 school year, only 67.97% males and 53.92% females were retained, a 14.05% difference between the genders. Additionally, of the 57 women who joined STEM-LLC in 2009, 17 (30%) left their STEM-major in the first year.

All students--males and females--admitted into the program can access the following: a one-time \$1,500 scholarship, access to a tutoring center, dedicated STEM-LLC faculty in STEM classes that are historically barriers to STEM-persistence (pre-Calculus, Calculus, Biology, Chemistry, and Physics), access to graduate teaching assistants and tutors and social activities throughout the year. Formation of STEM-LLC cohorts occurs around mathematics levels, taking into account the research stating that Calculus is a barrier for completion for STEM majoring students. All accepted STEM-LLC students test into and are enrolled within their first fall semester in either Pre-Calculus or Calculus 1.

*The GEMS Model:*

Couched within STEM-LLC, GEMS targets female first year students providing additional social and academic programming designed to increase retention, decrease dysfunctional career thinking and increase decidedness within major selection. Both STEM-LLC and GEMS, have as their primary goal, to increase the retention of students in STEM disciplines by providing them enhanced educational opportunities and support. GEMS, by offering a peer mentorship support network for STEM-LLC female students only, places a special retention emphasis on females.

Counteracting mentoring program limitations found in the literature review, GEMS utilized Roberts' (2000) definition of mentoring and the validated and reliable Career Thoughts Inventory and Career Decision Scale to examine mentoring program effectiveness in reducing dysfunctional career thinking and retention. Roberts' definition of mentoring from a business perspective, is "a formalized process whereby a more knowledgeable and experienced person actuates a supportive roles of overseeing and encouraging reflection and learning within a less experienced and knowledgeable person, so as to facilitate that person's career and personal development (Roberts, 2000, p. 162). Relying on Campbell and Campbell (1997) to some extent, the GEMS mentoring program provided guidance and support to mentees using specific and structured mentee-mentor interactions and matching. Levinson's (1978) definition, though highly cited within psychosocial development literature, merely supports Robert's definition, as mentors were trained against giving moral or emotional support. Mentees in need of such

services were referred to the campus counseling center as mentors were not trained to provide psychosocial support.

Kram and Isabella (1985) and Zalaquett and Lopez (2006) agreed that mentoring roles need not be confined to faculty. In GEMS, these functions are held by upper-level undergraduate students, a mentor coordinator, with ancillary support from academic advisors and faculty during monthly meetings. GEMS utilizes peer-group and individual-to-team mentoring approaches, with one-on-one mentoring available as requested by mentor or mentee. Though Luna and Cullen (1995) defined mentoring as formal or informal with both showing positive results, GEMS was created to be a formal mentoring program, managed and sanctioned by the university. Mentees were matched by a third party, and the schedule of activities was prescriptive (Chao et al., 1992; Kram & Isabella, 1985; Levinson et al., 1978; Phillips-Jones, 1982). The mentoring relationship in GEMS was formal and planned, as the mentors were assigned to the mentees by EXCEL staff; and mentees and mentors were grouped by major, mathematics courses and living arrangements (on or off campus). Mentors followed prescribed meeting times and methods of delivery (phone, face-to-face), social and networking events, and mentor leadership meetings. During these leadership meetings, mentors met monthly with EXCEL and GEMS coordinators to discuss mentee performance and obtain training. The mentoring relationship usually lasted for one academic year, i.e., the first year of the mentees. Beyond this period of one year, the relationship was not monitored by the program but could continue successfully.



### *GEMS Program: Pilot Year 2010-2011*

Pilot year activities and data were presented to deepen programmatic understanding of the GEMS mentoring program. Unless expressly stated, data collection year implementation mirrored the pilot year description which follows:

#### Mentee Recruitment

The researcher and STEM-LLC leadership determined all former STEM-LLC females would be solicited to apply for one of the open mentoring positions. Solicitation began prior to the pilot fall 2010-2011 academic year. In addition to being a STEM-LLC student, it was determined that mentors would need to have a 2.5 or higher UCF cumulative GPA to be considered. Based on the number of entering 2010 STEM-LLC female students, 15 mentors were chosen which allowed for four to five women per mentoring group. Concurrently, incoming STEM-LLC female freshman students were contacted to gauge interest in obtaining mentors through GEMS. Due to positive responses from both upperclass and incoming STEM-LLC females, intervention planning continued. A draft mentor application was presented to the STEM-LLC Assessment Committee for review. Once updated and approved, the mentor application was placed on the STEM-LLC website. An email invitation was drafted, and the initial recruitment list was accessed by STEM-LLC staff. On July 1, 2010 the initial recruitment message was sent by the STEM-LLC Program to upper class STEM-LLC female students. An additional three reminder emails were sent prior to the July 15, 2010 deadline. As of July 13, 2010, only 14 applications had been received so the STEM-LLC Assessment

Committee made the decision to extend the deadline by one week. Another reminder with the deadline extension was sent to all potential applicants. A decision was also made to send an individualized email to those students who had expressed interest during the original inquiry but had not submitted an application. Applicants were then contacted to schedule an interview.

Mentor interviews were held on July 22-23, 2010. Conducted by the researcher and STEM-LLC leadership, each interview lasted 15 to 30 minutes and consisted of the same nine standard questions. Approximately eight interviews were conducted by phone due to students not being on-campus during the summer term. Selected mentees were agreed upon by the researcher and STEM-LLC staff, and all applicants were notified of decisions on August 3, 2010. Based on the majors and numbers of entering 2010 STEM-LLC female students, a total of eight mentors were chosen from the Colleges of Science and Medicine, and an additional seven mentors were chosen from the College of Engineering and Computer Science.

#### Mentee Assignments to Mentors

On August 10, 2010, a final list of entering STEM-LLC female students was generated and used to build the 15 mentoring groups. Mentees were assigned to mentors based on two factors: major and living arrangements. Whenever possible, mentees were paired with a mentor of the same major. Though desired, this did not always occur due to disparities among numbers of female mentees and mentors within a STEM-major. Additionally, attempts to match mentees living in the same residence halls was a

secondary determinant adding at least two off-campus mentees to ease freshmen year social transition. Mentors were instructed via email to contact GEMS pod mentees between August 14 and 17, 2010, prior to the start of the academic year. The message included a reminder for the GEMS Kick-Off Social and STEM-LLC Welcome Party.

### Coordinator Recruitment Details

A coordinator was hired to assist the researcher and STEM-LLC staff in administering the GEMS program. The STEM-LLC Project Committee and researcher decided a 20-hour-a-week graduate student position would be sufficient to fill this role. Program delivery and development in higher education was a prerequisite for the coordinator position. In mid-July 2010, a draft of the GEMS coordinator job posting was presented to the STEM-LLC Assessment Committee via email for review and recommendations. Once updated and approved, the coordinator job posting and invitation were emailed to university department heads and over 300 College of Education graduate students. An additional email was sent to the Higher Education-Student Personnel listserv to solicit applications. Applicants were contacted to schedule interviews soon thereafter.

Coordinator interviews, conducted by the researcher and a STEM-LLC representative, were held on July 28 and 29, 2010 with one additional interview on August 3, 2010. Each interview lasted 30 minutes and consisted of 20 standard questions being asked of the interviewees. Decisions were made following the last interview, and all applicants were contacted by the researcher as to the results on August 4, 2010. The

chosen candidate was a female Ph.D. candidate in the Electrical Engineering program at the university with program delivery experience.

#### GEMS Mentor and Coordinator Training

With input from the STEM-LLC Project Investigator (PI), Co-PI, and the Assessment Committee, the researcher planned the first GEMS Mentor Training, scheduling it to occur the Thursday before classes began, August 19, 2010. By August 10, 2010, a basic agenda had been established and invitations were sent to presenters from the university student academic resource center (SARC) and the Counseling Center. SARC was employed to conduct training on student motivation. The Counseling Center conducted training on effective communication and referral skills. Other sessions were conducted by the researcher and STEM-LLC staff using the attached final agenda and training documents. The final agenda and training documents are attached.

Supplemental mentor training was held prior to the beginning of spring 2011 classes, covering needs which emerged during fall 2010. This was a short evening training the first day of classes, January 10. The GEMS coordinator worked individually with the researcher, STEM-LLC PI, and Co-PI on training deemed necessary, e.g., the creation of a GEMS process manual, mentor coordination and assessment delivery, and data handling.

### GEMS Networking Events

During the GEMS networking events, female STEM-LLC faculty were invited to share personal and professional experiences that led them on the STEM path. Six networking events were organized during the pilot first year. An additional purpose was to give mentors and mentees an opportunity to connect with outside-the-classroom atmosphere on career and major related topics and seek their advice, deepening the LLC experience (Crisp & Cruz, 2009; Nora & Cruz, 2007; Tinto, 2003).

Networking events were held monthly with speakers representing all major STEM-majors within the STEM-LLC. The fall networking events consisted of presentations by chemistry and environmental engineering professors and an assistant vice president of research held in September, November respectively. An additional networking event on academic advising occurred in October. All STEM-LLC advisors were present for this event where both mentees and mentors had an opportunity to plan their course schedules for the next academic semester and year. The spring networking event involved STEM-LLC mathematics and medical school professors and mathematics graduate teaching assistants held in January, February and March. The networking event led by GTAs was to allow mentors and mentees to learn about graduate school as an option for career development and common challenges on the path to graduation in a STEM major from individuals close in age.

### GEMS Socials

GEMS socials were organized in both the fall and spring semester to encourage co-mingling between mentoring pods and to socialize together as a large group. The fall semester social was well attended; however, the spring social was not due to its being scheduled the week before spring break. Following the sparse turnout, the GEMS project committee and researcher decided to have a larger number of smaller socials so that GEMS mentors and mentees could attend whichever social interested them the most.

### Mentor Mentee Biweekly Meetings

Mentors conducted bi-weekly face-to-face meetings discussing both researcher-recommended and mentee generated topics. During the bi-weekly meetings, the mentors and mentees elected to share personal feelings about academics and college life. Some chose to share more personal items such as relationship and family interactions. These meetings helped to ensure ongoing mentor-mentee and mentee-mentee interactions. One of the bi-weekly meetings was to be held as a social gathering at a mutually agreed upon location such as over dinner or dessert to deepen social relationships. Mentees completed reflections forms at the end of each meeting in a sealed envelope. The reflection forms were turned into the GEMS coordinator during the monthly mentor meeting. During the mentor meetings all GEMS mentors came together in a focus group-like setting with the coordinator, researcher, and STEM-LLC staff to share what was working. These meetings were very important in that data were collected to solidify the GEMS model during these times.

### GEMS Pilot Year Results

The GEMS program pilot year corresponded with the 2010-2011 academic year. The STEM-LLC 2010 cohort consisted of 203 students of which 131 were male and 72 were female. In addition to the STEM-LLC's enhanced educational opportunities, GEMS offered to female STEM-LLC students, consistent and continual interaction with a peer mentor (STEM-LLC upperclass female student), networking events with female faculty role models, social events, and the opportunity to express their opinions about potential improvements of the GEMS activities. GEMS relied on a management structure consisting of a GEMS project committee, a GEMS assessment committee, a GEMS coordinator, and 15 STEM-LLC upperclassmen who served as peer mentors.

Based on data obtained June 20, 2011, of the 72 female students who were recruited into the STEM-LLC/GEMS program in 2010, seven left the STEM disciplines, and one was disqualified from further attending UCF, resulting in 64 STEM-LLC/GEMS women still in STEM. Similarly, based on data obtained June 20, 2011, of the 131 male students who were recruited into the STEM-LLC program in 2010, 10 left the STEM disciplines, and four were disqualified from further attending UCF, resulting in 117 STEM-LLC men still in STEM as of June 2010. Therefore, the STEM-LLC male and female retention rates for the 2010 STEM-LLC cohort are 88.9%, and 89.3%, respectively. Hence, the goal of the GEMS program to equalize the STEM-LLC male and female retention rates was fulfilled. Furthermore, the goal of improving the retention rate of STEM-LLC female students was also fulfilled (the 2009 STEM-LLC female cohort had a retention rate of 70% (influenced only by STEM-LLC activities), compared

to the 88.9% retention rate of the 2010 STEM-LLC female cohort (influenced by STEM-LLC and GEMS activities)).

The academic progress of the GEMS mentees was tracked throughout the 2010-2011 academic year (performance in the gateway mathematics classes and UCF GPA). The GEMS Program Coordinator analyzed these data. In particular, the mathematics grades of the active versus occasionally active GEMS mentees (Test 1), the mathematics grades of the active versus non-active + occasionally active GEMS mentees (Test 2), the GPA of the active versus occasionally active GEMS mentees (Test 3), the GPA of the active versus non-active and occasionally active GEMS mentees (Test 4) were compared. The designation of a mentee being active, occasionally active, or non-active was based on an evaluation of the mentee's participation in the GEMS program activities by her corresponding mentor.

The grading scale used for the statistical analysis was taken from the Merrick School of Business, University of Baltimore. According to this grading scale GPA 3.67-4 = A, GPA 2.67-3.67 = B, GPA 1.67-2.67 = C, and GPA 0.67-1.67 = D.

Test 1 revealed that the average mathematics grade of the 33 active GEMS mentees was 3.26 with a standard deviation of 0.548, and the average grade of the 19 occasionally active GEMS mentees was 2.54 with a standard deviation of 0.672. Using a t-test applied to these average grades, it was found that there was a statistically significant difference in the average mathematics grade of the active GEMS mentees versus the average grade of the occasionally active mentees (in favor, of course, of the active mentees). In particular, the active mentees received the following grades: A



(27%), B (67%), C (6%), and the occasionally active mentees received grades of A (5%), B (37%), C (53%), and D or lower (5%).

Test 2 revealed that the average mathematics grade of the 33 active GEMS mentees was 3.26 with a standard deviation of 0.548, and the average grade of the 26 occasionally active and non-active GEMS mentees was 2.68 with a standard deviation of 0.743. Using a t-test applied to these average grades, it was found that there was a statistically significant difference in the average mathematics grade of the active GEMS mentees versus the average grade of the occasionally active and non-active mentees (in favor, of course, of the active mentees). In particular, the active mentees received the following grades: A (27%), B (67%), C (6%), and the occasionally active and non-active mentees received grades of A (12%), B (42%), C (38%), and D or lower (8%).

Test 3 revealed that the average GPA of the 35 active GEMS mentees was 3.38 with a standard deviation of .325, and the average grade of the 19 occasionally-active GEMS mentees was 2.97 with a standard deviation of .423. Using a t-test applied to these average grades, it was found that there was a statistically significant difference in the average mathematics grade of the active GEMS mentees versus the average grade of the occasionally-active mentees (in favor, of course, of the active mentees). In particular, the active mentees received the following grades: A (23%), B (77%), and the occasionally active mentees received the following grades of A (10%), B (74%) and C (16%).

Test 4 revealed that the average GPA of the 35 active GEMS mentees was 3.37 with a standard deviation of .325, and the average grade of the 27 occasionally-active +

not active GEMS mentees was 2.91 with a standard deviation of .471. Using a t-test applied to these average grades, it was found that there was a statistically significant difference in the average mathematics grade of the active GEMS mentees versus the average grade of the occasionally active + not-active mentees (in favor, of course, of the active mentees). In particular, the active mentees received the following grades: A (23%), B (77%), and the occasionally active +not active mentees received the following grades of A (7%), B (74%), C (15%), D (4%).

The results, reported above (Tests 1-4), revealed that GEMS may support increased 2010 STEM-LLC female retention rates (compared to 2009 STEM-LLC data), reducing the gap of female retention to 2010 STEM-LLC male retention rate. Additionally, it suggested that active involvement in GEMS activities was positively correlated to students' academic performance, i.e., GPA and grades in the first-year mathematics gateway classes.

#### *GEMS 2011-2012: The Intervention Year*

Participants in this study were a total of 201 males and females who made up the STEM-LLC cohort in the 2011-2012 academic year. Similar recruitment, training and activity strategies were used during the intervention year. Determination to use pilot year strategies was made based on focus group and qualitative assessment data not presented in this study, as the focus of this study was STEM talent and career development through reduction on dysfunctional career thinking.

All incoming STEM-LLC students (males and females), and parents learned of GEMS during the University's July 2011 Summer Orientation. Program offerings, researcher, and STEM-LLC faculty answered questions and presented to incoming students and parents after which all students who wished to participate in STEM-LLC and GEMS signed informed consent forms.

Females accepted into STEM-LLC had the opportunity to participate in GEMS and were assigned an upper-class female STEM-LLC mentor if they chose to join. All females elected to join GEMS. GEMS females had access to all STEM-LLC activities as well as GEMS social and academic programming. Mentor-mentee pods and STEM-LLC faculty and staff comprised the GEMS population. Members of GEMS access increased tutoring options at the STEM-LLC tutoring center, dedicated graduate teaching assistants, increased academic advising, mentorship by trained upper-class females, a myriad of social activities designed to increase their sense-of-community, networking events with female industry leaders, and university faculty and career advisement. This menu of services offered to GEMS mentees is collectively referred to as GEMS. In-depth detail about the component parts of the GEMS program is presented in the following sections.

### GEMS Mentors

Recruitment of GEMS Mentors began in April of 2011, the spring semester prior to new STEM-LLC cohort enrollment of fall of 2011. GEMS mentor employment opportunities were (a) posted in STEM-majoring common areas, (b) sent via email to all STEM-LLC sophomores, juniors and, seniors; (c) announced in STEM-LLC classrooms

and at the STEM-LLC Center. Because GEMS supports female participants in STEM-LLCs, potential mentors have to be part of the STEM-LLC as well. This was determined to be a key factor in the mentors' abilities to empathize with and provide social and academic guidance to mentees. Potential candidates submitted applications, including GPA, written statement outlining desire to participate and relevant experience, professor recommendation, resume, and fall 2011 class schedule. Before offering an interview, an industry partner and university STEM-LLC designee screened documents for minimum overall GPA, 3.0 on a 4.0 scale, mathematics class GPA, strength of written statement, previous work history and success in chosen STEM major. Face-to-face interviews were expected; however, consideration was given to applicants who had extenuating circumstances. Interview questions were derived from a sample provided by a workforce organization and amended by university staff to meet the specific needs of the research. Questions were designed to evaluate oral communication skills, ability to think through difficult scenarios in real time, desire to be a mentor, time availability to effectively participate and overall fit within GEMS. Deliberate selection occurred to ensure mentors represented diverse majors, race and ethnicities, personality types, and class standing, thus, providing a suitable cross section for mentees and reflecting a diverse snapshot within STEM at the university. Interviews were conducted by a STEM-LLC staff designee and an industry partner, and interviewees were ranked according to previously mentioned criteria. Higher ranks were obtained for increased GPA (overall and within mathematics coursework), oral communication skills, written statement, interview, and by STEM major which was given principal importance. It was paramount for the

researcher to ensure mentees were grouped into pods in which the mentor shared a similar major. Additionally, pairing mentees together by fall mathematics class served as the second most important factor for grouping by mentor.

### GEMS Mentor-Mentee Matching

A total of 17 GEMS mentors were selected using the previously described selection process. Among the 17 mentors were six former GEMS mentors (from the pilot year), five former GEMS mentees, and six new-to-GEMS females. All females selected as mentors were members of STEM-LLC, had above a 3.0 GPA and were majoring in STEM in their sophomore to senior years of study. The opportunity to serve as a GEMS mentee or mentor occurred during the pilot year, August 2010 through May 2011. Mentees were grouped according to major and fall 2011 mathematics course. Every effort was made to ensure that mentors had the same major as their mentees.

Initial mentee contact was initiated during July 2011 by selected GEMS mentors. A welcome to STEM-LLC GEMS email was drafted by the GEMS advisory council for mentor use. Matching of mentees to mentors occurred through a stratified and deliberate process. Again, grouping by mathematics class enrollment and STEM-major selection formed each GEMS pod. Calculus, the research-supported barrier to completion for STEM majors served to identify the first stratification measure (Robinson, 2003a). Understanding unique needs, stressors, and requirements of one STEM major over another further stratified the 75 future GEMS mentees. There was, however, some difficulty in matching similar majors due to low admission numbers of females. The 75

mentees declared the following majors at the beginning of Spring 2012: Computer Science (1), biomedical sciences/biotechnology (20), chemistry (1), forensic science (2), mathematics (3), statistics (1), and Biology (6), Engineering (28), science disciplines (10), and mathematics disciplines (3). Of the 17 GEMS mentors, seven were engineering majors, seven represented the sciences and three were in mathematics disciplines.

### GEMS Activities

GEMS activities were as follows: (a) bi-weekly face-to-face meetings the first and third weeks of each month, (b) mentor/mentee bi-weekly phone calls the second and fourth weeks of the month, (c) monthly networking events led by top female faculty, (d) individual mentor/mentee pod monthly socials, (e) GEMS-wide semester social (fall and spring), (f) Welcome Party where matched pair of mentor and mentees met and (g) two mentor training sessions.

### GEMS Mentor Training

Mentors attended mandatory two-day training before the beginning of the fall semester and before meeting mentees. The mentor training served two purposes: (a) team building between mentors and (b) communication of programmatic expectation and “how-tos.” Components of the training agenda were driven by programmatic needs of mentors, pilot year shortcomings, past GEMS mentor feedback, and university protocol. Training was led by a STEM-LLC staff designee and the researcher.

Mentor training began with an informal evening social event held by STEM-LLC

staff the night before training. The main goal of this event was to serve as an icebreaker for all mentors, to meet and begin the process of getting acquainted. Additionally, the overview and expectations for the two-day training were delivered to mentors. The first day of training was very focused and program-specific. The goal of the first day of training was to find an effective mix of socially entertaining events and effective informational sessions. Activities and icebreakers were designed to challenge the mentors to build teamwork and camaraderie among the group, many of whom were meeting for the first time. A key element to all icebreakers and teambuilding activities was the takeaways program facilitators designed for the training. Careful attention was given to ensure these activities helped to prepare mentors for all duties and responsibilities for the next 16 weeks.

In addition to training activities, informational sessions were designed to help develop the mentor's thinking as it relates to mentoring. Volunteers from the University Counseling Center, alumni guest speakers, and program facilitators all came together for information sessions on stress/wellness and referral skills. Mentors were given an overview of the situations they might face with mentees and were trained on how to properly refer a student to the Counseling Center for additional assistance if the need should arise. A guest speaker also discussed motivation, with key takeaways designed to show mentors how to keep their mentee pods motivated as well as to provide tools that could be used to remain motivated themselves. Day One concluded with a dinner for all mentors and program facilitators and discussion relating to expectations for Day Two. Day Two was the "nuts and bolts" day. Semester calendars, event descriptions, socials

brainstorming, and talking points for the first face-to-face meetings of the semester were delivered.

### Summary

This study sought to contribute research results to address gaps in the STEM talent and career development retention research present at the undergraduate level through a female mentoring intervention designed to gauge levels of dysfunctional career thinking within a STEM-LLC. Practices that increase retention of females, an underrepresented population in STEM, through career development were not present in the literature, but successes of mentoring, living-learning communities and career development as separate interventions were supported by academic research. In this chapter, methods used to determine mentoring's success on the reduction of dysfunctional career thinking with female first year STEM majoring students were described. The experimental design, instruments, analysis procedures, assumptions and limitations which framed this study were discussed. Causal comparative design using repeated measures MANOVAs and canonical correlations were employed to measure the influence of the GEMS mentoring program on career readiness and career decidedness among first-year STEM-majoring students in this study. The research study was conducted over a nine-month period with quantitative data derived from valid and reliable career assessments collected at specific time markers. Chapter 3 concluded with a complete description of the GEMS model including creation and implementation of pilot and intervention years. Brief pilot retention data were presented to provide



background for the study. The data analysis for the study is presented in Chapter 4.

Chapter 5 contains a summary and discussion of the findings.

## CHAPTER 4 DATA ANALYSIS AND RESULTS

### Introduction

Chapter four provided findings related to the four research questions which pertained to dysfunctional career thinking and the mentoring intervention. Findings were presented from quantitative data analyses. The overall purpose of this study examined the influence female mentoring had on dysfunctional career thinking. The research questions for the study were:

Research Question 1. What effect did the GEMS mentoring program have on career readiness as measured by the Career Thoughts Inventory?

Research Question 2. What effect did the GEMS mentoring program have on career decidedness as measured by the Career Decision Scale?

Research Question 3. What effect did participation in the GEMS program have on career readiness as measured by participation levels and the Career Thoughts Inventory?

Research Question 4. What effect did participation in the GEMS program have on career decidedness as measured by participation levels and the Career Decision Scale?

Null Hypothesis 1. No differences exist in career readiness, as measured by the CTI, between the GEMS and non-GEMS study participants

Null Hypothesis 2. No differences exist in career decidedness, as measured by the CDS, between the GEMS and non-GEMS study participants

Null Hypothesis 3. No relationship exists between GEMS participation and changes on the CTI

Null Hypothesis 4. No relationship exists between GEMS participation and changes on the CDS

The researcher used two assessments and their subscales to evaluate dysfunctional career thinking and determine influence of mentoring on females within a living-learning community as compared to their male counterparts also within the STEM-LLC. The quantitative data gathered included assessment administrations in August, November and April of students in their first year in 2011-2012. Assessments were administered by STEM-LLC mathematics professors during class time. Assessments allowed participants to self-report on the following subscales: (a) decision-making confusion, (b) commitment anxiety, (c) external conflict (d) career decision and (e) career indecision. This chapter, organized into two sections, provides an analysis of the quantitative data gathered to answer Research Questions 1 and 2 using Repeated Measures MANOVA's. The second section presents canonical correlation analyses used to answer Research Questions 3 and 4.

### Participant Demographics

A convenience sample of the population for the research study was the population for the STEM-LLC, 201 males and females. A total of 75 females comprised the intervention group. All females co-participated in GEMS and STEM-LLC, and 126 males participated only in the STEM-LLC.

### Quantitative Analysis

Research Questions 1 and 2 analyzed each dependent variable, subscale test scores across the participants' first year with the independent variable being time using repeated measures MANOVA's. Research questions 3 and 4 analyzed participation rates in three areas (mentor meetings, networking events, and socials) with assessment change scores from the August to April administration using canonical correlations. In review, the treatment group of females participated in the GEMS mentoring intervention which was situated into the STEM-LLC while males participated only in the STEM-LLC. To ensure fidelity of treatment, two trained coordinators at the university and two trained coordinators from industry worked together to administer the mentoring intervention. Pre-Calculus and Calculus professors were trained on assessment delivery by the STEM-LLC director who was trained using the assessment manuals and career development professor. Upon assessment, delivery coordinators collected, scored and entered data. The researcher trained all coordinators and maintained oversight during the intervention. Additionally, the researcher hand-checked each assessment following the three administrations and hired an external person to validate all 5,973 data points. Participants who were absent during assessment delivery had the option to complete the assessment upon return. Participants were also permitted to not test without repercussion. Scoring discrepancies between coordinators and researcher were addressed initially and then again during external data validation. Because assessments were scored based on publisher protocol, discrepancies amounted to an addition error and were easy to find and correct through the three levels of data control.

### *Preliminary Analyses*

Prior to running repeated measures MANOVAs and canonical correlations, tests for normal distribution, missing value analysis and data imputation were completed. Box-Plots were used for all assessment subscales to determine no outliers existed. Little's MCAR expectation maximization test was not statistically significant (Chi-Square = 209.571, DF = 194,  $p = 0.211$ ). Therefore, the researcher failed to reject the null hypothesis, suggesting data was missing at random. Missing value analysis using expectation maximization for missing data generation was run for all assessment subscales and separated by time. All August administrations of CTI and CDS were, therefore, inputted together; November and April were inputted in the same manner. Variables were then merged to make a complete data set. The August administration had six data points missing in each subscale (1.4% of data), and the August percentile subscale had 57 missing data items. November showed between 21 and 29 missing data points on the five subscales (9.7-13.4%). April had 60-61 items missing between each subscale, accounting for 27.8-28.2% of the data.

Pillai's Trace statistic is reported for the overall model in research questions 1 and 2, being more robust as the homogeneity of covariance is violated in Box's M ( $F(1, 200) = 1.581, p = 0.000$ ). This suggests the variance between each of the DVs was similar and the researcher rejects the null hypothesis. Additionally, sphericity was not violated for decision-making confusion, external conflict, and certainty but was for commitment anxiety and indecision.

The average CTI decision making confusion score for males decreased from August ( $M = 5.43$ ,  $SD = 6.03$ ) to April ( $M = 5.11$ ,  $SD = 6.20$ ). Though similar decreases in females were seen, levels of female decision making confusion were lower than males from August ( $M = 5.22$ ,  $SD = 6.10$ ) to April ( $M = 4.99$ ,  $SD = 4.82$ ). See Table 1 for a complete list of means and standard deviations by assessment subscales.

Table 1

*Descriptive Statistics for Assessment Subscales*

Subscales	Sex2	Mean	Std. Deviation
	0	5.43	6.031
AugCTIDMC2011	1	5.22	6.098
	Total	5.34	6.045
	0	4.63	5.688
NovCTIDMC2011	1	5.19	7.220
	Total	4.86	6.358
	0	5.11	6.202
AprCTIDMC2012	1	4.99	4.817
	Total	5.06	5.656
	0	10.06	6.545
AugCTICA2011	1	12.20	6.363
	Total	10.95	6.541
	0	8.03	6.240
NovCTICA2011	1	9.61	6.963
	Total	8.69	6.580
	0	7.50	5.718
AprCTICA2012	1	8.54	5.354
	Total	7.93	5.581
	0	2.19	2.376
AugCTIEC2011	1	2.94	2.810
	Total	2.50	2.585
	0	1.92	2.418
NovCTIEC2011	1	2.40	2.826
	Total	2.12	2.599
	0	2.30	2.533
AprCTIEC2012	1	2.89	2.619
	Total	2.55	2.579
	0	6.32	1.258
AugCDSCER2011	1	6.20	1.355
	Total	6.27	1.297
	0	6.61	1.350
NovCDSCER2011	1	6.66	1.480
	Total	6.63	1.402
	0	6.88	1.096
AprCDSCERS2012	1	6.77	1.024
	Total	6.83	1.066
	0	28.76	8.376
AugCDSIND2011	1	28.45	8.225
	Total	28.63	8.296
	0	27.40	9.326
NovCDSIND2011	1	27.55	8.765
	Total	27.47	9.077
	0	27.49	8.378
AprCDSIND2012	1	27.07	6.852
	Total	27.31	7.766

Note: Sex Female (1) Male (0)

### *Research Question 1*

Research Question 1. What effect did the GEMS mentoring program have on career readiness as measured by the Career Thoughts Inventory?

Null Hypothesis 1. No differences exist in career readiness, as measured by the CTI, between the GEMS and non-GEMS study participants

A repeated measures multivariate analysis of variance (MANOVA) was used to compare differences in dysfunctional career thinking of male and female STEM-LLC participants using the CTI. Only the females received the GEMS mentoring intervention. Pillai's Trace statistic is reported for the overall model. The analyses compared the means, standard deviations, and F ratios of the MANOVA statistic which was utilized to reduce the probability of the emergence of Type I errors within the results. The results of the multivariate and univariate analysis are displayed in Table 2.

According to Pillai's Trace the overall model was not statistically significant for interactions between the time and gender ( $F(1, 200) = 0.908, p=0.525, d=0.11$ ), however, the model was statistically significant for time ( $F(1, 200) = 11.168, p=0.000, d=0.118$ ) with mean differences for males ( $M= 26.23, SD= 21.690$ ) and females ( $M= 29.47, SD= 20.774$ ). Indicating no differences existed in career readiness levels, as measured by the CTI, between females who participated in GEMS situated within the STEM-LLC (treatment) and males who only participated in the STEM-LLC (comparison). Furthermore, the small effect sizes indicate differences between males and females were similar.



The researcher reported univariate results as significance for time was found. Univariate tests were run during the repeated measures MANOVA analysis to determine within and between subject effects for CTI subscales. No statistical significance was found within the interaction for gender, males in the STEM-LLC and females in GEMS and the STEM-LLC, and time for any CTI subscale, decision-making confusion ( $F(1, 200) = 0.443, p=0.649, d=0.002$ ), commitment anxiety ( $F(1, 200) = 0.807, p=0.447, d=0.004$ ) or external conflict ( $F(1, 200) = 0.258, p=0.773, d=0.001$ ). Analyzing between subject effects, differences existed between females and males for commitment anxiety ( $F(1, 200) = 5.077, p=0.025, d=.024$ ) and external conflict ( $F(1, 200) = 4.512, p=0.035, d=.021$ ) while decision-making confusion was not statistically significant ( $F(1, 200) = 0.013, p=0.911, d=.000$ ).

Using time as the construct and with sphericity assumed, commitment anxiety and external conflict were statistically significant while decision-making confusion was not. To expand, the subscale decision-making confusion decision-making confusion was not statistically significant ( $F(1, 200) = 0.445, p=0.641, d=0.02$ ) with the following mean differences within males ( $M= 5.06, SD= 6.171$ ) and females ( $M= 5.11, SD= 5.536$ ). Though external conflict was statistically significant for time ( $F(1, 200) = 12.223, p=0.034, d=0.016$ ) with mean differences within males ( $M= 2.32, SD= 2.515$ ) and females ( $M= 3.01, SD= 2.939$ ), the effect size of  $d= 0.016$  indicated similar construct levels between males and females (Cohen, 1988). Additionally, though Greenhouse-Geisser reported commitment anxiety as statistically significant ( $F(1, 200) = 27.494, p=0.000, d=0.116$ ) with mean differences among males ( $M=7.58, SD= 5.723$ ) and

females ( $M= 8.71$ ,  $SD= 6.004$ ) again the effect size was small. Results suggest differences existed in levels of commitment anxiety and external conflict within males who participated in the STEM-LLC only and females who participated in both GEMS and the STEM-LLC over time, however, small effect sizes indicated similar career readiness levels existed within males and females.

Table 2

*Differences in Career Thinking Gender and Time: Career Thoughts Inventory*

MULTIVARIATE <sup>a,b</sup>							
Within Subjects Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Time	Pillai's Trace	.236	11.168	10.000	834.000	.000	.118
Time * Sex2	Pillai's Trace	.022	.908	10.000	834.000	.525	.011

a. Design: Intercept + Sex2

Within Subjects Design: Time

b. Tests are based on averaged variables.

c. Exact statistic

d. The statistic is an upper bound on F that yields a lower bound on the significance level.

UNIVARIATE								
Source	Measure	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	
Time	CTIDMC	Sphericity Assumed	18.776	2	9.388	.445	.641	.002
		Greenhouse-Geisser	18.776	1.975	9.509	.445	.639	.002
		Huynh-Feldt	18.776	2.000	9.388	.445	.641	.002
		Lower-bound	18.776	1.000	18.776	.445	.505	.002
	CTICA	Sphericity Assumed	1071.867	2	535.934	27.494	.000	.116
		Greenhouse-Geisser	1071.867	1.941	552.253	27.494	.000	.116
		Huynh-Feldt	1071.867	1.968	544.635	27.494	.000	.116
		Lower-bound	1071.867	1.000	1071.867	27.494	.000	.116
	CTIEC	Sphericity Assumed	24.446	2	12.223	3.398	.034	.016
		Greenhouse-Geisser	24.446	1.987	12.302	3.398	.035	.016
		Huynh-Feldt	24.446	2.000	12.223	3.398	.034	.016
		Lower-bound	24.446	1.000	24.446	3.398	.067	.016
Time * Sex2	CTIDMC	Sphericity Assumed	18.270	2	9.135	.433	.649	.002
		Greenhouse-Geisser	18.270	1.975	9.253	.433	.646	.002
		Huynh-Feldt	18.270	2.000	9.135	.433	.649	.002
		Lower-bound	18.270	1.000	18.270	.433	.511	.002
	CTICA	Sphericity Assumed	31.458	2	15.729	.807	.447	.004
		Greenhouse-Geisser	31.458	1.941	16.208	.807	.444	.004
		Huynh-Feldt	31.458	1.968	15.984	.807	.445	.004
		Lower-bound	31.458	1.000	31.458	.807	.370	.004
	CTIEC	Sphericity Assumed	1.857	2	.928	.258	.773	.001

Source	Measure	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
	Greenhouse- Geisser	1.857	1.987	.934	.258	.771	.001
	Huynh-Feldt	1.857	2.000	.928	.258	.773	.001
	Lower-bound	1.857	1.000	1.857	.258	.612	.001

### *Research Question 2*

Research Question 2. What effect did the GEMS mentoring program have on career decidedness as measured by the Career Decision Scale?

Null Hypothesis 2.No differences exist in career decidedness, as measured by the CDS, between the GEMS and non-GEMS study participants

A repeated measures multivariate analysis of variance (MANOVA) was used to compare differences in career certainty and career indecision of male and female STEM-LLC participants using the CDS. Only females received the GEMS mentoring intervention within the STEM-LLC, males solely participated in the STEM-LLC. Pillai's Trace statistic was reported for the overall model. The analyses compared the means, standard deviations, and F ratios of the MANOVA statistic which was utilized to reduce the probability of the emergence of Type I errors within the results. The results of the multivariate and univariate analysis are displayed in Table 3.

According to Pillai's Trace the overall model was not statistically significant for interactions between the time and gender ( $F(1, 200) = 0.908, p=0.525, d=.11$ ), however, the model was statistically significant for time ( $F(1, 200) = 11.168, p=0.000, d=0.118$ ) with mean differences for males ( $M= 26.23, SD= 21.690$ ) and females ( $M= 29.47, SD= 20.774$ ). Indicating no differences existed in career certainty and indecision levels, as measured by the CDS, between females who participated in GEMS situated within the STEM-LLC (treatment) and males who only participated in the STEM-LLC (comparison). Furthermore, the small effect sizes indicate differences between males and females were similar.

The researcher reported univariate results as significance for time was found. Univariate tests were run during the repeated measures MANOVA analysis to determine within and between subject effects for CDS subscales, career certainty and career indecision. No statistical significance was found within the interaction for gender, males in the STEM-LLC and females in GEMS and the STEM-LLC, and time for either CDS subscale, certainty ( $F(1, 200) = 0.491, p=0.612, d=.002$ ) or indecision ( $F(1, 200) = 0.119, p=0.888, d=.001$ ). Furthermore, when analyzing between subject effects, no differences existed between females and males for certainty ( $F(1, 200) = 0.201, p=0.654, d=.001$ ) with mean difference for males ( $M=6.91, SD= 1.09$ ) and females ( $M= 6.77, SD= 1.123$ ) or indecision ( $F(1, 200) = 0.043, p=0.836, d=.000$ ) with mean differences for males ( $M= 27.22, SD= 7.710$ ). However, significance was found in univariate tests using time as the construct for certainty, with sphericity assumed, ( $F(1, 200) = 17.991, p=0.000, d=.079$ ), though Greenhouse-Geisser reported indecision was not statistically significant, ( $F(1, 200) = 2.652, p=0.077, d=.012$ ). Results suggest differences existed in levels of certainty for males who participated in the STEM-LLC only and females who participated in both GEMS and the STEM-LLC over time, however, small effect sizes indicated similar career certainty and indecision existed within males and females.

Table 3

*Differences in Career Certainty and Indecision by Gender and Time*

MULTIVARIATE <sup>a,b</sup>							
Within Subjects Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Time	Pillai's Trace	.236	11.168	10.000	834.000	.000	.118
Time * Sex2	Pillai's Trace	.022	.908	10.000	834.000	.525	.011

a. Design: Intercept + Sex2

Within Subjects Design: Time

b. Tests are based on averaged variables.

c. Exact statistic

d. The statistic is an upper bound on F that yields a lower bound on the significance level.

UNIVARIATE TESTS								
Source	Measure	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	
Time	CDSKER	Sphericity Assumed	34.182	2	17.091	17.991	.000	.079
		Greenhouse- Geisser	34.182	2.000	17.092	17.991	.000	.079
		Huynh-Feldt	34.182	2.000	17.091	17.991	.000	.079
		Lower-bound	34.182	1.000	34.182	17.991	.000	.079
	CDSIND	Sphericity Assumed	210.829	2	105.415	2.652	.072	.012
		Greenhouse- Geisser	210.829	1.825	115.537	2.652	.077	.012
		Huynh-Feldt	210.829	1.849	114.042	2.652	.076	.012
		Lower-bound	210.829	1.000	210.829	2.652	.105	.012
Time * Sex2	CDSKER	Sphericity Assumed	.933	2	.467	.491	.612	.002
		Greenhouse- Geisser	.933	2.000	.467	.491	.612	.002
		Huynh-Feldt	.933	2.000	.467	.491	.612	.002
		Lower-bound	.933	1.000	.933	.491	.484	.002
	CDSIND	Sphericity Assumed	9.424	2	4.712	.119	.888	.001
		Greenhouse- Geisser	9.424	1.825	5.164	.119	.871	.001
		Huynh-Feldt	9.424	1.849	5.098	.119	.873	.001
		Lower-bound	9.424	1.000	9.424	.119	.731	.001

### *Research Question 3*

A canonical correlation analysis was conducted using change scores for the Career Thoughts Inventory (CTI) as predictors of the three participation variables within GEMS to evaluate the multivariate shared relationship between the two variable sets: assessment change scores by subscales and participation points by activity type. The CTI change score set was comprised of subscale change scores from the third test administration in April and the first test administration in August for (a) decision making confusion, (b) commitment anxiety, and (c) external conflict. The participation set included points earned by mentees for attendance at (a) mentor meetings, (b) networking events, and (c) social events. Increasingly, large subscale scores reflected more dysfunctional career thinking in the decision making confusion, commitment anxiety, and external conflict constructs and corresponded with higher total CTI scores. Negative change scores indicated improved outcomes. Increasingly large values for participation points corresponded with higher attendance in GEMS activities. To improve linearity of the relationship between variables and a normal distribution, missing value analyses were applied by assessment subscale and time using expectation maximization techniques. Statistical assumptions for canonical correlations were tested, and data were found to be normally distributed. Standard errors of measurement were homoscedastics and relationships between variables were linear.

The analysis tested three roots with squared canonical correlations of .049, .024, and .002, for each successive root, none of which were statistically significant. Collectively, the full model across all functions was not statistically significant, Wilks's  $\lambda$



= 0.926,  $F(9, 467.43) = 1.66$ ,  $p = 0.09$ . Because Wilks's  $\lambda$  represents the variance unexplained by the model,  $1 - \lambda$  yields the full model effect size in an  $r^2$  metric. Thus, for the set of three canonical roots, the  $r^2$  type effect size was 0.074, which indicates that the full model explained only about 7%, of the variance shared between the variable sets. Table 4 presents the standardized canonical root coefficients and structure coefficients for roots 1, 2, and 3. The squared structure coefficients are also given for each variable.

Table 4

*Canonical Solutions for Career Thoughts Inventory Subscales for Roots 1, 2, 3*

	Root 1			Root 2			Root 3		
	Coef	rs	Rs2 (%)	Coef	rs	Rs2 (%)	Coef	rs	Rs2 (%)
Change Decision Making Confusion	0.53	0.08	0%	1.05	<u>0.15</u>	2%	1.13	0.99	98%
Change Commitment anxiety	-1.37	<u>.054</u>	0%	<u>0.50</u>	<u>0.47</u>	22%	0.03	0.70	49%
Change External Conflict	.748	.290	8%	<u>1.21</u>	<u>.765</u>	59%	<u>0.24</u>	0.58	34%

*Note.* Structure coefficients (*rs*) with negative values are underlined. Coef = standardized canonical function coefficient; *rs* = structure coefficient; Rs2 = squared structure coefficient.

*Research Question 4*

A canonical correlation analysis was conducted using mentee Career Decision Scale (CDS) assessment scores as predictors of the three participation variables within

GEMS to evaluate the multivariate shared relationship between the two variable sets, assessment change scores by subscales, and participation points by activity type. The CDS change score set was comprised of subscale percentile change scores from the third test administration in April and the first test administration in August for (a) certainty and (b) indecision. The participation set included points earned by mentees for attendance to (a) mentor meetings, (b) networking events, and (c) social events. Increasingly large subscale scores reflected more dysfunctional career thinking in the certainty and indecision constructs of the assessment. Therefore, negative change scores indicated improved outcomes. Increasingly large values for participation points corresponded with higher attendance in GEMS activities. To improve linearity of relationship between variables and normal distribution, missing value analyses were applied by assessment subscale and time using expectation maximization techniques. Statistical assumptions for canonical correlations were tested and data were found to be normally distributed. Standard errors of measurement were homoscedastics and relationships between variables were linear.

The analysis yielded three roots with squared canonical correlations of 0.014 and 0.004, for each root. Collectively, the full model across all functions was not statistically significant using the Wilks's  $\lambda = 0.982$ ,  $F(6, 386) = 0.573$ ,  $p = 0.752$ . Because Wilks's  $\lambda$  represents the variance unexplained by the model,  $1 - \lambda$  yields the full model effect size in an  $r^2$  metric. Thus, for the set of two canonical roots, the  $r^2$  type effect size was 0.018, which indicates that the full model explained only about 2%, of the variance shared between the variable sets. Table 5 presents the standardized canonical function

coefficients and structure coefficients for roots 1 and 2. The squared structure coefficients are given across the two roots for each variable.

Table 5

*Canonical Solutions for Career Decision Scale Subscales for Roots 1 and 2*

Variable	Root 1		Rs2 (%)	Root 2		Rs2 (%)
	Coef	rs		Coef	rs	
Change Certainty Percentile	1.09	.931	87%	.036	1.01	102%
Change Indecision Percentile	.397	-.033	0%	.365	.999	99%

STEM-LLC Retention Data

Using study intervention year 2011-2012 male STEM-LLC 81.82% of males (comparison) were retained while 77.33% of females (treatment) were retained. During the intervention year retention gaps between males and females reduced from 9% (2010-2011) to 4.5% (2011-2012). Looking at STEM-LLC male retention as compared to university wide STEM retention, males within the STEM-LLC were retained 16.56% more while females were retained 18.56% more than their university counterparts (EXCEL Retention Numbers”, Fall 2012 Report, Institutional Research Office, University of Central Florida). This data suggests GEMS impacted STEM-LLC female retention more than reported through statistical analyses presented above. The researcher made every effort possible to ensure that the only large programmatic change made

within the STEM-LLC was the implementation of GEMS. Therefore, the researcher posits GEMS was successful in retaining female participants within their STEM major.

### Summary

This study sought to partially fill the STEM talent and career development gaps in retention research present at the undergraduate level through a female mentoring intervention designed to gauge levels of dysfunctional career thinking within a STEM-living-learning community (LLC). To address the purpose of this study, the influence female mentoring has on dysfunctional career thinking, the researcher used two assessments and their subscales to evaluate levels of dysfunctional career thinking. These assessments and quantitative analyses determined influence of mentoring on females within a smaller LLC as compared to their male counterparts also within the LLC.

Chapter 4 provided findings related to the four research questions pertaining to dysfunctional career thinking and the mentoring intervention. Findings were presented from quantitative data analyses using repeated measures MANOVAs and canonical correlations. The quantitative data gathered included assessment administrations in August, November, and April of the first year students in 2011-2012. The first section of Chapter 4 was used to present an analysis of the quantitative data gathered to answer Research Questions 1 and 2 using repeated measures MANOVAs. The second section responded to Research Questions 3 and 4 through canonical correlations. In response to the first two research questions, the intervention, GEMS, showed no statistically

significant effect for time and gender. Significance was only found for time. No statistical significance was found in the analysis of data to answer the third and fourth research questions. Canonical correlations reported no significant relationship between participation and reduced dysfunctional career thinking.

Chapter 5 contains a brief summary of the research, the purpose of the study and a summary of the outcomes. The outcomes of the study are discussed as they relate to the literature reviewed and contribute to academic literature, followed by the limitations of the study and implications for future research.

## CHAPTER 5 CONCLUSION

### Introduction

To remain a competitive and innovative global leader the United States must address STEM supply and demand talent gaps (Beede et al., 2011; NSF, 2010). Interventions such as GEMS that promote retention and a decrease in dysfunctional career thinking over time within females help to secure U.S. economic standing as it increases supply of STEM proficient staff using STEM talent and career development practices. Furthermore, successful interventions within STEM career and talent development enables the U.S. to achieve: (a) STEM-proficient staff meeting employer demand; (b) reduced need for offshore research, development, and manufacturing due to lack of qualified U.S. staff; and (c) decreased reliance and recruitment of foreign nationals for high-tech positions (Beede et al., 2011; NSF, 2010, 2012). This research study sought to investigate the success of female mentoring as an undergraduate intervention utilizing career development practices to achieve reduced dysfunctional career thinking and STEM major retention. Within this study, decreased dysfunctional career thinking increased career decidedness, career certainty (Gati et al., 1996) and decreased male-female retention gaps when imbedded within a living-learning community (Beede, 2011; Seymour & Hewitt, 1996; Tinto 2003).

The review of literature presented research framing the need for gender-based mentoring in the U.S. as a vehicle for reduced dysfunctional career thinking and STEM talent and career development in five areas: (a) a brief historical account of the need for

STEM talent and workforce development; (b) role of career development in science education, mentoring, and STEM; (c) factors affecting barriers to entry and persistence in STEM; (d) mentoring for academic success; and (e) the role living-learning communities (LLC) play in retention. As addressed in Chapter 2, research support exists within career development and gender-based interventions in the literature, while research into mentoring and LLC supports increased retention as a result. Still, STEM gender-based mentoring literature was sparse. Furthermore, gender-based mentoring with a career development focus was virtually non-existent in the literature.

This chapter provides a direct link between available academic research and the findings of this study. Also, the researcher's personal experiences frame conclusions drawn in this chapter, as the researcher is a female minority professional within the STEM talent development industry.

The chapter opens with a brief summary of the research study and continues with the purpose of study and a summary of outcomes. Associations and inferences to established research are then presented and discussed in terms of how the findings contribute to academic literature. The chapter closes with a discussion of the limitations of the study and implications for future research.

### Purpose of Study

Based on the need for increased retention of females in STEM-majors, this research study examined mentoring program effects when situated within an already functioning living-learning community funded by NSF, called the STEM-LLC, at a large

urban university in the southeastern part of the United States. Assessing the effect of the GEMS (Girls Excelling in Mathematics and Science) mentoring program on retention, dysfunctional career thinking, and career decidedness comprised the overarching research study goals.

The researcher offered a model to large urban universities that increases retention of female first-year STEM-majoring students coupling career development, mentoring and living-learning community researched best-practices to decrease dysfunctional career thinking. Within this study, use of the GEMS model increased retention of females by 18.56%. Retention gaps between males and females during the intervention year reduced from 9% in 2010-2011, the pilot year, to 4.5% in 2011-2012, the intervention year. Prior to the pilot year, in 2009-2010, retention gaps were 15% and higher which prompted the need for GEMS. (EXCEL Retention Numbers, 2012).

The researcher used repeated measures MANOVAs and canonical correlations in the causal comparative research design evaluating mentoring's influence on first year females. Male voluntary participants (n = 126) comprised the comparison group, and female voluntary participants (n = 75) constituted the treatment group.



### Summary of Findings

Repeated measure multivariate analyses of variances analyzed differences between the interaction of mentoring and gender over time on dysfunctional career thinking using two assessments (Career Thoughts Inventory and Career Decision Scale) and their five subscales (decision-making confusion, commitment anxiety, external conflict, career certainty and career indecision). Canonical correlations were performed to analyze the effect participation rates had on student change scores on the CTI and CDS, indicating mentoring intervention effects on reducing dysfunctional career thinking and decidedness. Assessment data were collected three times throughout the first year (August, November, and April) and scored by coordinators, researcher, and an external data validator. Outlier determination and imputation of missing data was performed, taking Little's MCAR significance into account and missing values were replaced using expectation maximization principles. These data were then used to compare differences between 126 males enrolled in only the STEM-LLC and receiving no intervention to 75 females enrolled in both the STEM-LLC and receiving the GEMS mentoring intervention. Indepth analysis of the research questions follows:

*Research Question 1.*

What effect did the GEMS mentoring program have on career readiness as measured by the Career Thoughts Inventory?

Null Hypothesis 1. No differences exist in career readiness, as measured by the CTI, between the GEMS and non-GEMS study participants

Quantitative analysis of Research Question 1 revealed no statistically significant interactions between female and males on career thinking and career readiness constructs as measured by the Career Thoughts Inventory. However, the model was statistically significant for time ( $F(1, 200) = 11.168, p=0.000, d=0.118$ ) with mean differences for males ( $M= 26.23, SD= 21.690$ ) and females ( $M= 29.47, SD= 20.774$ ). Indicating no differences existed in career readiness levels, as measured by the CTI, between females who participated in GEMS situated within the STEM-LLC (treatment) and males who only participated in the STEM-LLC (comparison). Furthermore, the small effect sizes indicate differences between males and females were similar.

Therefore, the researcher accepted the null, as no differences were found to exist in career readiness constructs between the treatment, females, and comparison group, males, in the STEM-LLC. However, results suggest differences existed in levels of commitment anxiety and external conflict but not in decision making confusion between males who participated in the STEM-LLC only and females who participated in both GEMS and the STEM-LLC over time. Though, small effect sizes indicated similar career readiness levels existed within males and females. Indicating females who participated in both GEMS and the STEM-LLC exhibited reductions in dysfunctional

career thinking and increased career readiness over time as compared to males who only participated in the STEM-LLC. Lack of statistical significance in the decision making confusion (DMC) construct is expected as commitment anxiety (CA) and external conflict (EC) confound feelings of decision making confusion as defined by the CTI assessment. When looking at the mean scores for males and females, males exhibit lower means on all three CTI subscales over time, being more career ready and having less dysfunctional career thinking as compared to females.

Delving into the CTI subscales, decision making confusion reflects a student's inability to initiate or sustain STEM as a career choice, usually confounded by the other two CTI subscales, commitment anxiety and external conflict (Sampson et al., 1996). High commitment anxiety reflects female inability to commit to a career in STEM, and high external conflict reflects female inability to balance personal desires or importance of self-perceptions with those desires or areas of importance from significant external people, suggesting increased numbers of females in GEMS were not sure if majoring in STEM was the right decision whereas males within the STEM-LLC exhibited less anxiety about their career choice and major selection. Increased commitment anxiety in females may be due to external conflict surrounding gender-based or cultural norm conflicts or it may go against females general norms surrounding their career choice. Furthermore, females exhibited higher mean levels on indecision than males, indicating their certainty was less solidified than males in their STEM career choice, supporting researched findings of increased commitment anxiety and external conflict on the CTI (Osipow, 1986; Sampson et al., 1996).

Though repeated measures MANOVAs did not report significance for the female mentoring intervention, indicating time as the only factor in reducing levels of dysfunctional career thinking and increasing career readiness, GEMS impact cannot be discounted as inherent design limitations exist. First, students within the STEM-LLC elect to major in STEM and apply for admission into the LLC, suggesting some level of career readiness exists. Second, since a control group of females was not used in the study, there was no way to conclusively state that the intervention had no effect. Rather, reductions over time in dysfunctional career thinking and increases in readiness may, in fact, be narrowing the dysfunctional career thinking gap between males and females. This gap represents a future area for analysis. Third, overall male and female career readiness may occur naturally overtime due to STEM-LLC effects and may deepen through the use of mentoring; this constitutes another natural extension for research. Finally, it cannot be excluded that intervention outcomes will increase over time as an effect of maturation. This study represents an analysis of the first full year of the GEMS mentoring program. Increased retention, reduced dysfunctional career thinking, and programmatic stability due to GEMS' becoming part of the STEM-LLC culture constitute expected outcomes over time.

Inculcation of GEMS within the STEM-LLC reduced retention gaps between males and females and increased female retention rates. In 2009, STEM-LLC data reported only 56.14% of females were retained, with the advent of the GEMS pilot in 2010-2011, 60.56% were retained with the retention rate increasing to 77.3% during the intervention year of 2011-2012 (EXCEL Retention Numbers, 2012). It should be noted

that this retention cannot be attributed to GEMS without additional analyses due to previously stated research design limitations. However, since the only factor that changed in the STEM-LLC from 2009 to 2012 was the addition of the mentoring component, it is likely GEMS increased female retention and reduced levels of female dysfunctional career thinking.

Study findings suggest university, K-12 science, and STEM educators would benefit from including career development and mentoring constructs to understand and support female career choice and retention in STEM. The research placed importance on filling gaps within mentoring and career development in STEM. Creating a structured mentoring intervention, training and supporting mentors and guiding mentor-mentee interactions, embedding opportunities for females to challenge gender-based conflicts and general norms associated with STEM careers and using the STEM-LLC as the foundation for the intervention were deliberate, research supported and systematic.

Implications of reductions in dysfunctional career thinking reported by the Career Thoughts Inventory, and supported by GEMS retention data, are paramount to U.S. success in STEM talent and career development. Again, STEM talent and career development shortfalls are, at the core, supply and demand issues (DOLETA, 2006; U.S. GAO, 2005, 2006; NSB, 2010, 2012). Furthermore, though prior researcher showed females to be underrepresented, recruited at lower rates, and retained at lower rates than their male counterparts in STEM, few studies were conducted examining the effectiveness of mentoring and LLCs on female first-year retention (NSF, 2008). This study added to the literature by providing a seamless, career-focused intervention

designed to mollify limitations in previous LLC and mentoring studies. With fewer numbers of females viewing STEM as a career option, and an attrition rate of 40% by graduation (Chen & Weko, 2009), the mentoring intervention in this study was necessary to determine interventions that reduce levels of dysfunctional career thinking and to quell the cry for STEM professionals in the United States (Feller, 2011; Hiro, 2010).

At the university level, increasing the stability of a female's career choice in STEM and supporting her persistence past the first year allows her to access and have more STEM-related career experiences. These additional experiences may increase career readiness by decreasing decision making confusion, commitment anxiety and external conflict. Career interventions during the second year within the STEM-LLC include undergraduate research experiences, networking events, socials and internships. Retention past the first year permits females to shift focus from the decision making process itself to thoughts of career pathways. Retention and assessment data suggest use of the GEMS model within an LLC increases the supply of females moving towards graduating and working in STEM. An increase in female STEM graduates subsequently adds to workforce diversity in gender, race, ethnicity, and ideas.

The importance of STEM talent and career development comprises part of the political platform as evidenced by both U.S. presidential candidates in 2012 touting the need for jobs, education, and energy alternatives. This study suggests first-year female retention increases when mentoring and career development practices are employed within a living-learning community to reduce dysfunctional career thinking. Ultimately, interventions such as GEMS may support the U.S. in meeting international competitive

demands by: (a) increasing STEM-proficient female staff to meet employer demands; (b) reducing the need for outsourcing research, development and manufacturing due to lack of qualified U.S. staff; and (c) decreasing reliance and recruitment of foreign nationals for high-tech positions (Feller, 2011; Hira, 2010; Obama for America, 2012; Kelly, 2012).

### *Research Question 2*

What effect did the GEMS mentoring program have on career decidedness as measured by the Career Decision Scale?

Null Hypothesis 2. No differences exist in career decidedness, as measured by the CDS, between the GEMS and non-GEMS study participants

Quantitative analysis of Research Question 2 revealed no statistically significant interactions between female and males on career certainty and career indecision constructs as measured by the Career Decision Scale. However, the model was statistically significant for time ( $F(1, 200) = 11.168, p=0.000, d=0.118$ ) with mean differences for males ( $M= 26.23, SD= 21.690$ ) and females ( $M= 29.47, SD= 20.774$ ). This indicated differences existed in career certainty and career indecision levels between females who participated in GEMS situated within the STEM-LLC (treatment) and males who only participated in the STEM-LLC (comparison). The small effect sizes, however, indicated differences between males and females were similar.

Therefore, the researcher accepted the null, as no differences were found to exist in career certainty or career indecision between females who participated in GEMS and

the STEM-LLC (treatment), and males who only participated in the STEM-LLC (comparison group). However, results suggest differences existed in levels of female career certainty versus their male counterparts, but not within career indecision. This indicated females who participated in both GEMS and the STEM-LLC exhibited increased career certainty over time as compared to males who only participated in the STEM-LLC. Lack of statistical significance in career indecision may be due to GEMS increasing career certainty over time and may be supported by significant CTI findings of reductions in commitment anxiety and external conflict between males and females. When looking at the mean scores for males and females, males exhibited lower means on both CDS subscales over time (with the exception of November's certainty score), were more career decided and had less career indecision as compared to females.

Though repeated measures MANOVAs did not report significance for the female mentoring intervention, indicating time as the only factor in reducing career indecision and increasing career certainty, GEMS impact cannot be discounted as inherent design limitations exist. First, students within the STEM-LLC elect to major in STEM and apply for admission into the LLC, suggesting some level of career decidedness exists. Second, since a control group of females was not used in the study, there was no way to conclusively state that the intervention had no effect. Rather, reductions over time in career indecision and increases in career certainty may, in fact, be narrowing the decidedness gap between males and females. This gap represents a future area for analysis. Third, overall male and female career decidedness may occur naturally overtime due to STEM-LLC effects and may deepen through the use of mentoring; this



constitutes another natural extension for research. Finally, it can be expected that intervention outcomes will increase over time as an effect of maturation. This study represents an analysis of the first full year of the GEMS mentoring program. Increased retention, increased decidedness, and programmatic stability due to GEMS' becoming part of the STEM-LLC culture constitute expected outcomes over time.

To reiterate, inculcation of GEMS within the STEM-LLC reduced retention gaps between males and females and increased female retention rates. In 2009, STEM-LLC data reported only 56.14% of females were retained. With the advent of the GEMS pilot in 2010-2011, 60.56% were retained with the retention rate increasing to 77.3% during the intervention year of 2011-2012 (EXCEL Retention Numbers, 2012). Study findings suggest university, and K-12 science and STEM educators, would benefit from including career development and mentoring constructs to understand and support female career choice and retention in STEM. The researcher placed importance on filling gaps within mentoring and career development in STEM. Creating a structured mentoring intervention, training and supporting mentors and guiding mentor-mentee interactions, embedding opportunities for females to challenge gender-based conflicts and general norms associated with STEM careers and using the STEM-LLC as the foundation for the intervention were deliberate, research-supported and systematic.

Implications of increased decidedness reported by the Career Decision Scale and supported by GEMS are analogous to those outlined in Research Question 1. Low undergraduate retention in STEM perpetuates supply shortfalls within STEM talent and career development at the national level. Career interventions designed to identify

indecision, solidify career certainty and support student decidedness in their STEM major selection may increase the STEM workforce supply. Although women make up almost half of the United States workforce, they account for only 24% of the US STEM workforce (Beede et al., 2011; NSF, 2010). Though females in STEM earn 33% more than females in comparable non-STEM positions with a smaller gender-wage gap in STEM jobs, recruitment and retention within K-20 STEM courses of study has not increased significantly (Beede et al., 2011; Department of Commerce, 2011; NSB, 2010, 2012). Lack of retention due to low STEM career decidedness adversely impacts business and industry's sustenance of the STEM career pipeline. Furthermore, increased economic, global competition, and national safety concerns add pressure to the K-20 system to reduce STEM educational gaps in the pipeline. The findings of this study suggest that GEMS may be successful in increasing female retention and career decidedness, thereby reducing the STEM supply and demand gap. The mentoring intervention uses career development constructs within a living-learning community to increase career decidedness and retention over time, all of which prior researchers have indicated remove persistence barriers in females (Campbell & Campbell, 1997; Gati et al., 1996; Kahle et al., 1993; Tinto, 2003).

Similar outcomes are expected when career decidedness increases as when dysfunctional career thoughts decrease. At the university level, increasing the stability of females' STEM career choices and supporting persistence past the first year enables females to (a) access additional career related interventions such as undergraduate research experiences and internships; (b) focus thoughts on career pathways rather than

just the decision making process itself; (c) ultimately increase the supply of females graduating and working in STEM; and (d) add to the diversity of gender, race and ethnicity, and ideas to the STEM workforce.

### *Research Question 3*

What effect did participation in the GEMS program have on career readiness as measured by participation levels and the Career Thoughts Inventory?

Null Hypothesis 3. No relationship existed between GEMS participation and changes on the CTI

Canonical correlations were used to create a model to measure correlations between change scores on CTI administrations from August to April with mentee, female, participation in GEMS. Collectively, the full model across all roots was not statistically significant. Therefore, the researcher accepted the null, as no relationship existed between participation in GEMS and career readiness. In determining if increased career readiness was explained by higher participation rates, the full model returned an effect size of only about 7%, indicating the full model explained a small percentage of the variance shared between readiness and GEMS participation. Given the effects for each root, none of the roots were considered noteworthy in the context of this study (5%, 2%, and 0% of shared variance, respectively). Rates of participation may, in fact, not be a significant factor for increasing career readiness. Rather, factors prevalent in the literature and presented in Chapter 2 could explain stated increases in readiness over time, increased female retention, and reduced gender retention gaps: (a) use of a

structured mentoring program (Campbell & Campbell, 1997; Jacobi, 1991; Nora & Crisp, 2007); (b) female participants feeling increased sense of community due to LLC and mentoring (Kahveci et al., 2006; Pascarella & Terrezini, 1980, 1991; Roberts, 2002; Tinto, 2003); (c) increased social outlets, and (d) removal of barriers for retention using increased academic and social activities within mentoring and living-learning communities (AAUW, 2008, 2010; Brickhouse et al., 2000; Kahle, 1993; Tinto, 2003). Not evident in the analysis was if amount of participation (more than one event, or participation at all, at least one event) correlated with reduced dysfunctional career thinking, i.e., if additional analysis to determine if rate of participation correlated with career readiness or if student self-selection to participate in mentoring predisposed females to increased career readiness over time. Also not evident was if the fact that a structured program (GEMS) existed where female mentees knew low test grades, low attendance and other factors triggered academic advisors and mentors to make contact with students prompted female mentees to participate in GEMS activities, thus, increasing readiness.

U.S. STEM talent deficits framed the need for this study that was specifically designed to address female underrepresentation in STEM. Tinto (2003) posited that increased retention was garnered by fostering an environment that reduced gender barriers, such as attitudes, perceptions and self esteem. GEMS, a structured mentoring intervention, was designed to meet these outcomes. Though participation rates were not shown to explain increases in career readiness, LLC and mentoring literature stated both are vehicles supporting female retention. Situating the conceptions of Campbell and

Campbell (1997), Kahle et al. (1993) and Gati et al. (1999) about mentoring, gender, and career decision making into Tinto's (2003) research on living-learning community success, GEMS increased female retention within the STEM-LLC, increased female career readiness, and reduced dysfunctional career thinking levels as shown by the Career Thoughts Inventory. GEMS supported Tinto's (2003) argument; retention success is experienced when universities employ interventions within living-learning communities by fostering a sense of community, a need expressed in female mentoring research. Furthermore, researchers have attributed increased retention to students' increased campus involvement garnered through faculty and peer interactions, networking events and socials within GEMS. Enabling female GEMS students to be more satisfied, more successful, and persist at higher levels than students not involved in similar activities (Astin, 1975, 1995; Kuh et al., 1991; Pascarella, 1980, 1982; Pascarella & Terenzini, 1991; Noel et al., 1985).

#### *Research Question 4*

What effect did participation in the GEMS program have on career decidedness as measured by participation levels and the Career Decision Scale.

Null Hypothesis 4. No relationship existed between GEMS participation and changes on the CDS

Canonical correlations were used to create a model to measure correlations between change scores on CTI administrations from August to April with mentee, female participation in GEMS. Collectively, the full model across all roots was not statistically

significant. Therefore, the researcher accepted the null, as no relationship existed between participation in GEMS and career decidedness. Determining if increased career decidedness was explained by higher participation rates, the full model returned an effect size of only about 2%, indicating the full model explained a small percentage of the variance shared between readiness and GEMS participation. Given the effects for each root, none of the roots was considered noteworthy in the context of this study (1% and 0% of shared variance, respectively). Rates of participation may, in fact, not be a significant factor for increasing career decidedness; rather, participation in structured mentoring with career development programming may share in the effect.

Committing to a career choice is an essential psychosocial task for college students (Campbell & Cellini, 1981; Folsom & Reardon, 2000; Gati et al., 1996). Researchers have shown career-oriented interventions such as GEMS reduce dysfunctional career thinking and career indecision while increasing career decidedness and vocational identity, including gains in self-concept, self-esteem, and increased student retention rates (Folsom et al., 2002; Folsom & Reardon, 2000; Johnson & Smouse, 1993). Participation in networking events, mentor meetings, and socials allowed females to challenge and uncover areas of indecision within their STEM career choice. Additionally, students who participate in undergraduate career activities have higher graduation rates as compared with the general student population (81% compared with 69%) and have graduated with fewer credit hours on average than the general population (110 compared with 132), saving students time and money as they enter the workforce earlier (Folsom et al., 2002; Osborne et al., 2007). GEM may well be

expected to show these attributes as future outcomes. They also constitute areas of future research within STEM career and talent development.

Because students' attitudes toward mathematics and science are important variables in career selection and decidedness, GEMS aimed to create areas for participation including opportunities to network, forging relationships with female industry and academic leaders outside of the classroom. Though the statistical analyses showed no effect on decidedness levels and participation, researchers have posited that this removal of a barrier is essential to female retention (Kahle et al., 1993). Kahle et al.'s (1993) model systematically examined the variable effects on female interest, confidence, achievement, aspiration, and retention in science and informed the creation of GEMS.

Furthermore, females and minorities were less likely to persist in a STEM field major during college than male and non-minority students (NSB, 2007). Fewer females and minorities receive bachelor's degrees in STEM fields for two reasons: both groups are less likely to pick a STEM major initially, and if they do, they are less likely to remain in that major (Chen & Weko, 2009; Griffith, 2010). GEMS aimed to alleviate the second problem through mentoring and career decidedness interventions such as networking events, mentor meetings, and socials. Though participation rates in these prescriptive activities were not shown to explain the increases in career decidedness, the literature emphatically stated that living-learning communities and mentoring are vehicles for female retention. GEMS increased female retention within the STEM-LLC, increased female career decidedness, and reduced dysfunctional career thinking levels as

shown by the Career Decision Scale situating program creation and implementation in research-supported LLC, mentoring and career theory outcomes.

### Implications

United States supply of STEM-proficient staff does not meet industry demand (National Science and Technology Council. 2006; NSB, 2010, 2012; U.S. DOLETA, 2006; U.S. GAO, 2005, 2006). From 2000 to 2010, the need for STEM jobs increased by 7.9%, rising to 7.6 million (5.5% of the U.S. labor force). This growth in STEM demonstrated an increase of three times the rate of other fields and is expected to grow an additional 17% from 2008 to 2018 compared with 9.8% for other jobs according to a 2011 U.S. Department of Commerce report (Langdon et al. (2011). Furthermore, the report stated STEM jobs grew three times as fast as growth in non-STEM jobs over the past 10 years. Although women make up almost half of the United States workforce, they account for only 24% of the US STEM workforce (Beede et al., 2011; NSF, 2010).

In response to national STEM talent and career development needs this research study sought to investigate the effect an all-female mentoring program had on career readiness and career decidedness on first year STEM majoring college students with Mathematics Scholastic Assessment Test (SAT) scores between 550 and 650. Research findings suggest female mentoring, when housed within a living-learning community that employs career development constructs, reduces dysfunctional career thinking and increases career decidedness over time leading to increased female retention within STEM.



Lack of recruitment, retention, and training within STEM adversely impacts business and industry's sustenance of a STEM career pipeline. Interventions, such as GEMS, whose goals increase female retention over time through the reduction of dysfunctional career thinking decreases supply shortfalls. Additionally, the chasm between STEM proficient staff supply and demand may be minimized when systematic and successful retention efforts for females are employed at the undergraduate level. The findings of this research study suggest that the intervention, GEMS, increased female retention and decreased dysfunctional career thinking over time, addressing needs identified by Beede et al. (2011). Beede et al. posited that female disparities in STEM were caused by the lack of female role models, gender stereotyping, and less family-friendly flexibility. Female underrepresentation in STEM remained consistent over the past decade despite increases in the college-educated workforce, further exemplifying the need for interventions that use career development practices to support STEM retention .

Gati et al (1996) and other career development researchers attribute retention gaps between males and females and low retention rates within females at the undergraduate level to dysfunctional career thinking. Stating committing to a career choice is a paramount psychosocial task for college students (Campbell & Cellini, 1981; Gati et al., 1996; Folsom & Reardon, 2000). GEMS sought to address these concerns through programming. Furthermore, evidence suggest women and minorities respond best in more collaborative learning experiences which include working with mentors and was, therefore, employed within GEMS (Green & King, 2001). Mentoring programs and living-learning communities such as GEMS are research-supported retention strategies

within undergraduate degree programs, as they foster higher sense-of-community and provide academic support (Campbell & Campbell, 1997; Tinto, 2003). Therefore, though sparse research on effects of STEM-centered LLC with mentoring components were available, effective uses of mentoring and LLC's as separate interventions leading to increased retention and academic success abound (Astin, 1975, 1995; Cohen, 1995; Girves et al., 2005; Kuh et al., 1991; Pascarella, 1980; Pascarella & Terrenzini, 1991; Noel et al., 1985) and thus, were used to guide this research study. GEMS offers direct career assistance and provide information and social-emotional support, thereby assisting first-year females students in their transition from high school (Hubard, 2011).

Adding to the growing research in the STEM, this study showed there is relevance in using career development within STEM programming to drive retention. Prior mentoring, living-learning community, and female retention research within education and psychology relate research findings to increased female retention. Furthermore, career development literature has posited that reductions in dysfunctional career thinking increases certainty and ultimately retention for all students. Though an experimental design was not employed in this study, there is relevance suggesting the viability of career measures to explain effectiveness within STEM programs, specifically gender-based STEM programs. It also suggests that science educators might benefit from incorporating career assessments to help explain and understand issues around career decidedness, career certainty, and retention.

Further adding to the sparse literature in STEM talent and career development, this study supported that time is an important factor in reducing dysfunctional career

thinking in both males and females. Though conclusive statements cannot be made regarding GEMS mentoring intervention significance within this study, as the design was causal comparative rather than experimental, prior research into mentoring, career development, and living-learning communities exist throughout academic literature. Specifically, mentoring programs exhibit increased retention and effectiveness when defined and structured (Campbell & Campbell, 1997; Jacobi, 1991; Nora & Crisp, 2007). Removal of social, attitudinal and gender roadblocks increase female retention, and were included in programmatic design of GEMS (AAUW, 2008, 2010; Brickhouse et al., 2000; Kahle, 1993). Situating interventions within a highly functioning living-learning community to drive retention (Pascarella & Terezini, 1980, 1991; Tinto, 2003) is well documented in the literature and GEMS was systematically embedded in the LLC using this context. Missing from STEM literature, but employed within this intervention, were career development constructs and their role in increasing female career readiness and career decidedness.

Two assessments were used to gauge dysfunctional career thinking. These added to the sparse literature available on career thinking and decidedness within STEM. The Career Thoughts Inventory (CTI) assessment reported levels of career thinking and career readiness using decision making confusion, commitment anxiety, and external conflict as subscales. Based on the results of data analysis, the following conclusions can be made: females exhibited higher levels of dysfunctional career thinking than males and over time both groups decreased dysfunctional thoughts, solidifying their STEM career choice. The Career Decision Scale assessment reported levels of career decidedness using career

certainty and career indecision as subscales. Based on the results of data analysis presented, the following conclusions can be made: females exhibited lower levels of career decidedness than males, and both groups increased career certainty over time, solidifying their STEM career choices. Increased female retention and reduced retention gaps exist despite non-significance between mentee participation levels in mentoring meetings, networking events and socials, and change scores on the CTI and CDS. Findings suggest the career-development-driven structured-female-mentoring-program provided success not reported by statistical analyses. Future analysis, using a control group and experimental design, could, perhaps, produce definitive statements.

Retention data suggests GEMS impacted STEM-LLC female retention despite non-significance reported through repeated measures MANOVA's and canonical correlations. The researcher made every effort to ensure the only large programmatic change made within the STEM-LLC was the implementation of GEMS. Prior to 2010 the male-female retention gap within the STEM-LLC was 15% and higher, prompting the need for GEMS. Within the intervention year (2011-2012) male retention was 81.82% (comparison) and female retention was 77.33%. Following implementation of GEMS retention gaps reduced from 15% to 9% during the pilot year (2010-2011) to 4.5% during the implementation year (2011-2012). Furthermore, GEMS retained female participants at a higher rate when compared to university wide STEM retention, males within the STEM-LLC were retained at 16.56%, and females were retained at 18.56% (EXCEL Retention Numbers, 2012). Therefore, pending future analysis to address study limitations, the researcher posits GEMS was successful in retaining female participants

within their chosen STEM major. Additionally, the researcher submits GEMS as a model for universities desirous of using career development to drive retention within LLC's.

### Recommendations for Future Research

To meet industry, economic and labor needs within the United States, STEM talent and career development best practices and research must flourish in academic literature with researchers paying special attention to needs within STEM recruitment, retention and training for underrepresented populations from pre-K-20. This study added to the sparse STEM academic literature proving time as a factor for reducing dysfunctional career thinking, increasing readiness and certainty of STEM major selection by embedding career development practices within mentoring and living-learning communities. Both interventions increase retention in underrepresented populations. Though a step in the right direction, many unanswered questions and limitations persist. To further impact and reduce inherent study limitations, career analyses using a control group of analogous females and analyses of longitudinal effects of retention and STEM career pursuits should be investigated. Additionally, necessitated by STEM policy decision makers at industry, economic, and political levels, transmittal of research outcomes outside academia is paramount to funding and programmatic success of STEM talent and career development.

This study added to the literature, providing tangible practices to reduce the STEM talent and career development shortfalls within the United States. A supply and demand issue at its core, increasing STEM-proficient staff to meet industry need

dominates both presidential candidate platforms and should, therefore, be reflected in academic literature (Obama for America, 2012,; DOLETA, 2007; GAO, 2005, 2006; NSB, 2010, 2012). Job creation and talent development represent the major need within the United States. STEM careers are the only careers dubbed recession-proof with need so high commercials on MTV, CNN and major broadcast networks promote training in STEM careers funded by both public and private entities (HWOL/DEO, 2012; Kelly, 2012).

Although, career theory offers explanations to how and why a person will persist and offers suitability characteristics by career (Gati et al., 1996; Sampson et al., 1999), sparse research within career theory and STEM talent and career development exists. Strategic interventions focused on retention through career development practices may increase persistence of STEM-majoring students. Researchers show reductions in dysfunctional career thinking and increased retention within business and psychology literature (Gati et al., 1996). Mentoring within living-learning communities (LLC) has increased retention in many areas. Research-supported strategies have provided success for students in many academic areas and may also lead to retention success for STEM-majoring first-year students (Campbell & Campbell 1997; Kahle et al., 1993; Pascarella & Terezzi, 1991; Tinto, 2003). Though mentoring and LLC literature depict increased academic success and retention rates, only this study has researched the effect career development strategies exhibit when couched within mentoring and LLC interventions. Furthermore, though researchers have shown females as underrepresented, recruited at lower rates, and retained at lower rates than their male counterparts in STEM, few studies

have examined the effectiveness of mentoring and LLCs on female first-year retention (NSF, 2008). With fewer numbers of females viewing STEM as a career option and an attrition rate of 40% by graduation (Chen & Weko, 2009), reduction of dysfunctional career thinking is necessary to ensure adequate numbers of STEM professionals in the United States (Feller, 2011; Hiro, 2010). This study contributed to filling STEM career and talent development gaps present in U.S. universities by integrating research-supported mentoring, LLCs, and gender strategies with career development theory to reduce dysfunctional career thinking and increase retention of first-year STEM-majoring students within a living-learning community.

This study investigated the effects an all-female mentoring program had on career readiness and career decidedness of first-year STEM-majoring college students with mathematics SAT scores between 550 and 650. Through career development assessments and mentoring programmatic interventions, it was found that undergraduate females who participated in GEMS (a) were more likely to be retained in their STEM major; (b) had decreased levels of dysfunctional thinking over time while participating in the GEMS intervention; (c) had lower levels of career indecision over time while participating in GEMS; and (d) had higher levels of career readiness and career decidedness over time while participating in GEMS.

In order to meet the STEM supply shortfall, industry demand, and talent development needs, the following should be on the research agenda of academics:

1. What indecision or confusion factors are experienced by women in STEM fields? Which interventions show research-supported retention and STEM talent development success at all education levels?
2. What career development factors combat dysfunctional career thinking and indecision at all levels of the STEM education pipeline?
3. What are the characteristics of successful females in the STEM industry and what are the factors that led them to persist and advance up the career pipeline?
4. What are the factors that increase female entrepreneurship and innovation in STEM? Filling these gaps within STEM talent and career development is paramount to U.S. economic success and possibly may lessen, if not avert, future recessions and rampant joblessness.

Finally, though not a focus of the study, the impact of teachers on STEM retention and recruitment constitutes another important line of research. STEM talent and career development at the undergraduate level may exhibit increased success when students are aware and prepared for both STEM opportunities and coursework prior to post-secondary education. Future areas of STEM talent and career development research within K-12 education include: (a) evaluation of current STEM programming including analyses of success and effectiveness in recruiting students into STEM fields of study, (b) understand and examine career thinking within K-12 students and the role teachers play in student career thinking and decidedness, (c) uncover STEM program effects on career decidedness and thinking, (d) uncover teaching delivery methods within STEM that



increase career awareness and foster career thinking in K-12 students, (e) examine STEM industry's role in developing career thinking and decidedness in students, and (6) examine effective teacher experiences with STEM industry that support teacher delivery and teacher support of student career development within STEM. Filling these gaps within STEM talent and career development at the teacher and K-12 level is paramount to achieving U.S. competitiveness in the global marketplace.

### Summary

In conclusion and responding to need expressed by national agendas, industry, and academic entities for career and talent development in STEM, this research study examined mentoring program effects when situated within an already functioning smaller living-learning community at a large urban university. The research study adds to the academic literature within STEM, science education and career development. Findings suggest that over time female mentoring decreases dysfunctional career thinking, increases career certainty, increases female retention, and decreases gender retention gaps when embedded within a living-learning community, using career development constructs coupled with female retention practices to drive programming. Additionally, this study began the career development conversation within STEM and science education at the undergraduate level, providing colleges and universities with a structured first-year female mentoring model to drive female retention. The GEMS model may be ideal for colleges and universities without STEM career planning courses that have lower

than average female retention in STEM, and utilize living-learning communities to remove persistence barriers for all students.

APPENDIX A  
INSTITUTIONAL REVIEW BOARD APPROVAL



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](http://www.research.ucf.edu/compliance/irb.html)

From : **UCF Institutional Review Board #1  
 FWA00000351, IRB00001138**  
 To : **Michael Georgiopoulos, Cynthia Young, Melissa Falls**  
 Date : **January 21, 2011**

Dear Researcher:

On 1/21/2011 the IRB determined that the following proposed activity is not human research as defined by DHHS regulations at 45 CFR 46 or FDA regulations at 21 CFR 50/56:

Type of Review:	IRB Initial Submission Form
Project Title:	UCF STEP Pathways to STEM: From Promise to Prominence (the project is called EXCEL.)
Investigator:	Michael Georgiopoulos
IRB ID:	SBE-11-07396
Funding Agency:	National Science Foundation
Grant Title:	UCF STEP Pathways to STEM: From Promise to Prominence
Research ID:	N/A

University of Central Florida IRB review and approval is not required. This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are to be made and there are questions about whether these activities are research involving human subjects, please contact the IRB office to discuss the proposed changes.

On behalf of the IRB Chair, Joseph Bielitzki, DVM, this letter is signed by:

Signature applied by Janice Turchin on 01/21/2011 12:15:26 PM EST

IRB Coordinator

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