1999

A longitudinal evaluation of factors associated with retaining women in science and engineering

Christina Marie Osslund Gandhi
Iowa State University

INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.

Bell & Howell Information and Learning
300 North Zeeb Road, Ann Arbor, MI 48106-1346 USA

UMI®
800-521-0600

A longitudinal evaluation of factors associated with retaining women in science and engineering

by

Christina Marie Osslund Gandhi

A dissertation submitted to the graduate faculty

in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Major: Psychology (Counseling Psychology)

Major Professor: Douglas L. Epperson

Iowa State University

Ames, Iowa

1999

Graduate College
Iowa State University

This is to certify that the Doctoral dissertation of

Christina Marie Osslund Gandhi

has met the dissertation requirements of Iowa State University

Signature was redacted for privacy.

Major Professor

Signature was redacted for privacy.

For the Major Program

Signature was redacted for privacy.

For the Graduate College

TABLE OF CONTENTS

ABSTRACT

This study investigated the longitudinal effects of a Living Learning Center (LLC) on women studying engineering, science, and mathematics. The intervention was designed to decrease social isolation within women studying traditionally male-dominated career fields. Secondary goals included increasing LLC participants' retention within nontraditional academic majors and enhancing LLC participants' academic performance within nontraditional courses of study. Finally, increasing LLC participants' university retention, overall academic performance, self-efficacy, and college adjustment were tertiary objectives. Based on previous research, it was hypothesized that women participating in the LLC would report less social isolation, greater major and university retention, higher academic performance, and greater self-efficacy and college adjustment than women studying nontraditional majors housed in traditional residence halls. It was further hypothesized that members of the LLC would experience increasing levels of academic performance, adjustment, and retention over the span of their college careers. Finally, demographic and outcome variables were assessed for their predictive power of university and major retention. Three cohorts were studied in the present evaluation that included 149 LLC participants and 207 non-participants.

Results of the investigation were mixed. Results suggested that decreasing social isolation within LLC participants was achieved. Although no differences were found between the participant groups in university retention, findings indicated greater nontraditional major retention among LLC participants than non-participants, and participants achieved higher retention percentage rates than non-participants within each cohort for each year of the study. No differences were found in academic performance between the two groups and all respondents attained relatively high academic grades. Overall, both groups indicated high levels of adjustment, self-efficacy, confidence, social

support, academic performance, and retention. Also, a number of variables were found helpful in predicting retention at the university and in nontraditional majors.

The study's findings suggest that LLCs can be beneficial in facilitating students' acclimation to the college environment, which in turn may increase retention rates. Evidence was not found to support previous research indicating increased academic performance within participants of LLCs. As one of few studies on the effects of LLCs with women in nontraditional academic majors, the current investigation represents a starting point for other such research.

INTRODUCTION

Although women now comprise approximately 50% of the United States college population and professional workforce (Betz & Fitzgerald, 1987; Geppert, 1995), they remain underrepresented in several traditionally male-dominated careers. Technical fields such as the physical sciences, mathematics, and engineering, hereafter referred to as science and engineering for clarity and convenience, are particularly dominated by men; in 1992 13% of physicists, 11% of geologists, and 9% of all engineers were women (National Science Board [NSB], 1993).

Wilson (1992) argued that such gender stratification in the workforce is detrimental for women and society. First, all citizens should be treated equally and women should be encouraged to enter fields in which they have been historically inhibited. The author stated that with greater numbers of women and minorities becoming skilled workers, the nation's economic stability will increasingly rest on successfully training these individuals and incorporating them into the workforce. Second, this incorporation will provide critical resource renewal. Fresh perspectives and new strategies will strengthen our nation's ability to continue achieving technological milestones. Third, the author argued it is important that more members of society are educated in science and technology. A knowledgeable public will make informed political and economic decisions regarding issues such as medical research and technological advances.

Wilson's (1992) arguments suggested that discounting or underutilizing women's talents reduces individual and societal accomplishments. Identifying and eliminating barriers to women's pursuit of nontraditional careers has begun addressing these concerns. A review by Betz and Fitzgerald (1987) described two sets of barriers that deter women from following nontraditional careers. Internal barriers consist of self imposed attitudes and beliefs which hamper women's pursuit of nontraditional professions; external barriers are

factors imposed by the environment that dissuade women from these fields. Although they have been differentiated, an interconnection exists between internal and external barriers as well. For example, self imposed attitudes may be formulated based upon factors imposed by the environment; at the same time, self imposed attitudes may affect the selection of one's environment.

Incongruent interests are a potential internal barrier to women entering science and engineering fields. Research has demonstrated that interests predict career choice (e.g., Lapan, Shaughnessy, & Boggs, 1996; Chipman, Krantz, & Silver, 1992), and Keller, Piotrowski, and Rabold (1990) found that 45% of a student sample labeled their primary determinant of career choice as "matches my personality." Interest inventories have suggested that women hold stronger interests in traditionally female fields than in traditionally male fields. Additionally, women who have or develop interests in nontraditional areas pursue careers in these fields more readily than women with more traditionally female interests (Betz & Fitzgerald, 1987; Betz & Hackett, 1981). Mathematics interests appear to play an integral role in career interest formation and selection of science and engineering occupations. Sells (1980) termed math coursework completion the "critical filter" for women entering nontraditional fields and other research has demonstrated that attitudes toward math are positively related to nontraditional career choice (e.g., Chipman et al., 1992; Lefevre, Kulak, & Heymans, 1992). Although there may be a biological basis for different interests, it is possible that differential socialization and opportunities affect women's attitudes and interest development, thereby influencing the career fields women consider.

Other hypothesized internal barriers to women's pursuit of nontraditional careers are aptitude and achievement performance. Several researchers have indicated that women's mathematical aptitude test scores are lower than men's scores (e.g., Lent, Lopez, & Bieschke, 1991; Goldman & Hewitt, 1976), while others have found no gender differences in

general aptitude (e.g., Adelman, 1994; National Science Foundation [NSF], 1994). The research findings on gender differences in achievement have been mixed as well (e.g., Hackett, Betz, Casas, & Rocha-Singh, 1992; Astin, 1977). These disparate findings have prompted several researchers to hypothesize that aptitude and achievement may not be the actual barriers for women; rather, they proposed that women possess high performance expectations and withdraw from nontraditional programs of study when these high expectations are not met (Meade, 1991; Ware, Steckler, & Leserman, 1985). While some research has supported this hypothesis (Seymour, 1995; Ware et al., 1985), other findings have not (Schaefers, 1993). More research is needed to determine the effects of aptitude, achievement, and performance expectations on women's pursuit of nontraditional careers.

Self-efficacy about performance has been suggested as an additional barrier for women studying nontraditional majors (e.g., Betz & Fitzgerald, 1987; Chipman et al., 1992). Betz and Hackett (1981) first applied the theory of self-efficacy (Bandura, 1977) to women's nontraditional career choice and found that women possess lower self-efficacy in fields that require significant mathematics coursework. Lent, Brown, and Larkin (1984, 1986, 1987) confirmed that students with low self-efficacy for completing science and engineering degree requirements achieved lower academic grades and withdrew more often from their majors than students who reported high self-efficacy. It appears, then, that heightening women's self-efficacy of succeeding at scientific and technological careers could increase their participation in these areas. Betz and Hackett (1981) suggested that strong encouragement from parents and educators, access to positive female role models, and greater perceived successes could enhance women's self-efficacy to pursue nontraditional careers.

These internal barriers can be difficult to counter because researchers and program developers have relatively little control over individual characteristics. While programming

can be implemented to cultivate interest, strengthen performance, and increase self-efficacy in male-dominated fields, some might argue that interventions targeted on environmental barriers would be more fruitful. External barriers can be less difficult to investigate and interventions are more easily implemented during transitions from life at home to the collegiate experience.

Of particular concern to educators in university settings are the academic preparation and the learning environments provided. Because gender employment stratification can be traced to unequal numbers of men and women in collegiate programs of study for male-dominated careers (NSF, 1994), and because collegiate training is the final step before entering the professional workforce, research on barriers for women at this stage of career choice is especially salient.

Freeman (1979) argued that "an academic situation that neither encourages nor discourages students of either sex is inherently discriminatory against women because it fails to take into account the differentiating external environments from which women and men come" (p. 198). The result of this "null academic environment" is subtle discouragement of women from entering nontraditional careers, which is intensified when women lack other social support (Freeman, 1979; Betz, 1989). Freeman (1979) further found that while both genders felt ignored by collegiate faculty, men reported more support from parents and friends than did women.

Such low levels of social support from educators, parents, and peers are potential external barriers to women pursuing nontraditional careers. One study reported that 80% of surveyed female engineers believed the primary reason for such low numbers of women in engineering was a lack of school counselor encouragement to pursue such careers (Meade, 1991). Another study indicated that while over 60% of women pursuing nontraditional academic majors reported encouragement from their parents to enter a nontraditional field,

only 19% of women in traditional programs of study reported such encouragement (Houser & Garvey, 1983). Similarly, Houser and Garvey (1983, 1985) reported that women in nontraditional majors perceived more social support from their peers than did women in more traditional majors. It is possible that with more support from educators, parents, and peers, a greater number of women would feel empowered to enter a nontraditional field.

Other research has suggested the importance of providing role models for women contemplating nontraditional academic majors. Accessibility to role models could counter the negative effects of low social support. Indeed, research has indicated that positive role model influences predicted women's high career goals and educational choices (Hackett, Esposito, & O'Halloran, 1989). Hackett et al.'s (1989) study utilized an instrument that might be assessing support and encouragement from specific sources rather than role models, but their research supports the notion that external sources affect women's career choices. Further, successful women in nontraditional fields have emphasized the importance of utilizing role models and other mentors throughout their academic and professional careers (National Research Council's Committee on Women in Science and Engineering, 1994). The importance of support and modeling suggests that programs directed at elevating social support and assisting women in making career choices seem one way to increase women's attraction to and retention in nontraditional careers.

Another external barrier hypothesized to affect women's nontraditional career choice is the potential conflict between career requirements and personal roles. Research has shown that college students are concerned about integrating personal lives and careers (Swanson & Tokar, 1991; Morgan, 1992), and women who prioritized their family roles highly were less likely to enter a nontraditional academic major (Ware & Lee, 1988). Many women perceive traditional occupations or fields with a higher percentage of women and working mothers as more supportive of family roles than nontraditional fields. Indeed,

Arnold (1993) reported that women withdrew from nontraditional majors at all educational levels due to concerns about successfully merging their careers with their roles as wives and mothers. At the same time, other research has indicated that some women are not concerned about role conflicts (e.g., Lips, 1992; Sullivan, 1992). For example, Rodenstein and Glickauf-Hughes (1979) stated that women in traditional and nontraditional careers reported more satisfaction with their careers than single women in the workforce and greater contentment in their family lives than full-time homemakers. It appears, then, that more research is needed to evaluate the effects of anticipated role conflicts on nontraditional career choice.

Interventions for Women in Nontraditional Career Paths

A number of interventions have been developed to assist women in overcoming both internal and external barriers that keep them from pursuing nontraditional career paths. Special academic and social programming for undergraduate women in male-dominated programs of study exist on many college campuses across the nation. More intense interventions, Living Learning Centers (LLCs), are now being implemented for this population. LLCs are unique living arrangements shared by individuals of a particular population; the extra programming provided and the anticipated social support among members are expected to enhance university retention and the confidence, performance, and adjustment of the participating students.

Varied forms of LLCs have been in existence for 30 years (Pascarella, Terenzini, & Blimling, 1994) and have focused on several populations, such as first year students (Elton & Bate, 1966), high ability students (DeCoster, 1968), forestry majors (Madson, Kuder, Hartanov, & McKelfresh, 1976), and students of engineering across several ages (McKelfresh, 1980; Schroeder & Griffin, 1976; Taylor & Hanson, 1971). Research has

investigated the effects of LLCs on participants' academic performance, retention, and adjustment (e.g., Blimling, 1993; Williams, Reilley, and Zgliczynski, 1980).

Research has demonstrated that after taking pre-enrollment differences into account, first-year LLC participants achieved higher academic scores than first-year students in other residence halls (e.g., Pascarella & Terenzini, 1981; Schroeder & Griffin, 1976). A recent study reported that first-year female LLC members achieved higher grade-point averages than first-year women living on traditional residence hall floors (Kanoy & Bruhn, 1996). Further, the investigation found that the LLC members attained higher grade-point averages than predicted by their college entrance exam scores, while the women living on other residence hall floors yielded lower grades than anticipated. Other research found that LLC members attained higher academic standing than control groups among high-ability students (DeCoster, 1966, 1968), male first-year engineering students (Taylor & Hanson, 1971; Schroeder & Griffin, 1976), and female first-year pre-pharmacy students (Schroeder & Belmonte, 1979). Some research has not supported the association of LLC membership with high academic achievement (e.g., Pemberton, 1969; Barnes, 1977; McKelfresh, 1980), and continued research is needed with various populations to assess the relationship between living in an LLC and academic performance.

Program evaluators have also assessed the effects of participation in an LLC on student retention. Blimling (1993) indicated that thirty years of research have demonstrated that students who participated in LLCs were more likely to remain in their programs of study and at the university than students not living in LLCs. One study found that after two academic years 70% of male engineering students were retained in their majors, while only 51% of male engineering students in other residence halls remained enrolled in engineering (Schroeder & Griffin, 1976). Chapple (1984) reported that two years after entering the university 81% of science majors housed in proximity were retained at the institution; only

67% of science majors housed randomly were still enrolled at the university. Although a few studies have failed to find significant differences in retention between LLC members and students living in traditional residence halls (e.g., Taylor & Hanson, 1971), most findings have suggested that LLC membership is positively associated with student retention in curricula and at the university.

Many researchers have suggested that students living within LLCs were more satisfied at the university and better adjusted to their surroundings than students living in other campus residence halls (e.g., Pascarella & Terenzini, 1980, 1981; Schroeder & Griffin, 1976; Arminio, 1994), although some studies have produced mixed results indicating that students are highly satisfied with one aspect of the campus community and less satisfied with another (e.g., Magnarella, 1975; Centra, 1968). In addition to using self report data, researchers have assessed student satisfaction by comparing retention rates within university housing. These statistics suggested that members of LLCs remain on the same residence hall floor more frequently than students in other residence halls (e.g., DeCoster, 1968; Schroeder & Belmonte, 1979; Felver, 1983) and supported other findings that LLC members were more pleased with their campus community than students not living in LLCs.

Although program evaluations have produced some mixed results, the findings of studies investigating LLC effectiveness generally have indicated that students residing in LLCs achieved higher academic performance, greater retention, and better personal adjustment when compared to students living in traditional campus housing. Specific to the proposed study, three incoming classes of first-year women in nontraditional majors at Iowa State University were provided the option of sharing residence facilities with other women in similar majors. Programs similar to the one being evaluated exist at other universities, with the first beginning in 1989 at Rutgers University. Surprisingly, these programs have collected only minimal data from their participants, and few results have been published in

refereed journals. The lack of published research on these programs calls for a systematic analysis of such interventions.

Purpose of the Proposed Study

A living learning center was established at Iowa State University of Science and Technology for the first time during the 1995-1996 academic year. This intervention was designed to decrease social isolation within women studying traditionally male-dominated career fields. Secondary goals included increasing LLC participants' retention within nontraditional academic majors and enhancing LLC participants' academic performance within nontraditional courses of study. Finally, increasing LLC participants' university retention, overall academic performance, self-efficacy, and college adjustment were tertiary objectives. A program evaluation was completed using data collected during the first year of the intervention and recommendations were instituted aimed at enhancing positive effects for program participants (Gandhi, 1997). Data collection continued throughout the first three years of the intervention. The proposed study is unique in two primary ways. First, it integrates the research fields of living learning centers and women in science and engineering. Second, it utilizes a longitudinal research design to measure effects of an LLC on women in science and engineering. The primary purpose of this study is to evaluate the effectiveness of this intervention on academic performance, adjustment, and retention among women studying science and engineering.

Hypotheses

It is hypothesized that women residing in the LLC will experience lower social isolation than women living in traditional residence halls. It is further hypothesized that third-year participants in the LLC will report higher grades and higher retention in their programs of study and at the university than third-year non-participants. Also, it is hypothesized that the third-year residents in the LLC will report greater confidence in

academic and social endeavors and greater acclimation to classes and the university community than third-year students not residing in the LLC. Finally, it is hypothesized that similar trends will be found in comparisons of first and second-year LLC participants and non-participants.

REVIEW OF THE LITERATURE

History of Women in Education

The number of women achieving post secondary education has continued to increase since the last century. Women nevertheless continue to be underrepresented in certain traditionally male-dominated academic majors. According to Betz and Fitzgerald (1987), institutions of higher education in the early 19th century were reserved primarily for men. The few colleges that matriculated women did so reluctantly or with the intention of aiding women in their household duties. Colleges were viewed as opportunities to provide educated men with educated wives and to teach the domestic arts of baking, sewing, and childrearing (Betz & Fitzgerald, 1987). Several events, including the founding of women's colleges, the construction of land-grant institutions, and the number of male casualties in the Civil War provided opportunities for women to obtain post-secondary degrees. Although there were few employment opportunities outside of the home after obtaining a college degree, women comprised 21% of the college population in 1870. A century later in 1979, women's enrollment had reached 48% of the college population (Betz & Fizgerald, 1987).

Undergraduate women of today have a variety of career and educational opportunities and many proceed into graduate programs. Women received 56.2% of all master's degrees and 43.4% of all doctoral degrees in 1991 (NSF, 1994). These figures reflect a strong commitment to graduate education on the part of women; however, women continue to be underrepresented in technical fields such as physical science and engineering, which provide high remuneration and status. Specifically, 35% of master's degrees in science and engineering and 26% of doctoral degrees in science and engineering were awarded to women in 1991 (NSF, 1994). In engineering, biomedical engineering had the highest percentage of female graduate students at about 25%. Industrial engineering and metallurgical engineering followed, with almost 20% of the

population being women. The lowest percentages of female graduate students were in mechanical engineering and aerospace engineering, with fewer than 10% of the students being women (NSF, 1994). Similarly, under 25% of graduate students in computer science were women, and women comprised only 14% of physics graduate students. In contrast, women constituted approximately 45% of graduate students in the biological and social sciences (NSF, 1994).

Horner (1972) highlighted that while women are now encouraged to pursue advanced education, traits supported in the academic community such as independence, leadership, and competition are often viewed as incompatible with femininity. A recent study investigating the attrition of women from male-dominated academic majors presented evidence that some male students perceive women who are interested in nontraditional fields as "unnatural" (Seymour, 1995). More specifically, male students in the sample characterized such women into one of four categories: as inherently ugly, as expending too much energy in academics precluding them from attending to their appearances, as having lost their attractiveness after they entered the nontraditional field, or as lesbian. The study's female participants were aware of their male classmates' attitudes, and the women stated that they frequently hid or downplayed their academic achievements because their male classmates perceived women's high performances as threatening. While this study highlighted misperceptions and gender communication difficulties in a collegiate setting, women have experienced such impediments to entering the workforce in these fields as well.

History of Women in the Workforce

Although the number of women in the workforce has increased, women remain underrepresented in several traditionally male-dominated fields. A century ago women rarely worked outside of the home (Betz & Fitzgerald, 1987), yet today women comprise

51% of the workforce (Geppert, 1995). This increase in women's participation in work outside of the home began in the early 1940s when women were encouraged to fill those jobs left behind by men serving in the American armed services (Betz & Fitzgerald, 1987).

Women have continued to enter the workforce in greater numbers since that time, and the number of working women is greater today than the number of working men. The economic gains associated with this increase in workplace participation are less than might be anticipated, however, because most women work in occupations predominated by women. Women are overrepresented in "pink collar" occupations, such as waitress, clerical worker, elementary school teacher, librarian and housekeeper, which often provide lower salaries and social status than professions in which the majority are men (Betz & Fitzgerald, 1987; Betz, 1994). In the early 1990s, for example, while women held 88% of elementary school teacher positions and 51% of all social scientist posts, women comprised only 9% of all engineers, 13% of physicists, and 11% of geologists (NSF, 1994; NSB, 1993). Therefore, while women have increased their overall percentage in the workforce and are entering some scientific fields in greater numbers, they remain greatly underrepresented in technical fields such as the physical sciences and engineering.

Because many of the traditionally male-dominated professions are associated with relatively greater remuneration and status, significant economic losses for women result from gender stratification in the workforce. However, women lose more than these external rewards through such stratification. Self-actualization and dream pursuit are forfeited when women feel pressured to remain in traditionally female-dominated occupations. Additionally, academic fears can restrain capable women from considering or persevering in technical fields dominated by men. Yet, women's underrepresentation in nontraditional fields produces costs not only to women, but to society as a whole (Betz & Fitzgerald, 1987). Several researchers have contended that the nation needs to draw upon all talented

resources to maintain technological competitiveness, to increase technology, and to train future scientists and engineers (Wilson, 1992; Bickart, 1991; Lane, 1988; Ivey, 1988; Koshland, 1988; Pfafflin, 1984; Reuss & Vogel, 1989). The authors asserted that society loses a valuable resource by not forthrightly encouraging more women to enter these fields, and Bickart (1991) challenged the field to double the number of bachelor's degrees awarded to women and minorities in the decade preceding the next millennium. In addition to restricting technological advancements, underutilizing women's talents in nontraditional areas may perpetuate stereotypes and contribute to communication problems between men and women. Working together in various environments with mutual respect for abilities encourages accurate perceptions and cross-gender communication. It appears, then, that there is much to gain through the identification and elimination of barriers to women's pursuit of nontraditional career paths.

In their review of the literature, Betz and Fitzgerald (1987) found that significant obstacles to women pursuing nontraditional careers often have been divided into two basic categories: internal and external barriers. Internal barriers consist of idiosyncratic ideas and attitudes, such as incongruent personal interests, weak performance abilities, and low levels of self-efficacy, that deter women from choosing nontraditional professions; external barriers are factors imposed on the individual by the environment, such as real and perceived role conflicts between career and values, low social support, and unsupportive academic and workplace atmospheres that have been found by some to diminish women's desires to work in a nontraditional field. The following discussion of facilitating and inhibiting factors for women in nontraditional career paths is organized around these two categories of barriers.

Internal Barriers to Women Studying Science and Engineering

Congruence of Interests with Science, Math, and Engineering

Many studies have found that interest areas for the developing individual are an important predictor for future career choice (NSF, 1994; Lent, Brown, & Hackett, 1994; Fassinger, 1990; Borget & Gilroy, 1994; Chipman et al., 1992; Lefevre et al., 1992; Keller et.al., 1990; Dick & Rallis, 1991; Borgen & Seling, 1978). Keller et al. (1990) indicated that the primary determinant of career choice for 45% of their undergraduate sample was "matches my personality." Other research has shown that men often were enticed to science and engineering professions by the anticipated financial rewards of these positions; sincere interest in scientific and engineering fields was of greater importance to women than men in choosing these careers (Dick & Rallis 1991).

Additional research has confirmed that interests predict occupational choice (Lapan et al., 1996; Lent et al., 1994; Borget and Gilroy, 1994; Chipman et al., 1992). In their review of the literature on women's interests, as assessed by various revisions of the Strong Interest Inventory, Betz and Fitzgerald (1987) found that women demonstrated higher interest scores in traditionally female areas (e.g., clerical work and children's education) and exhibited lower interest scores in traditionally male areas (e.g., engineering and technical science). Women who already have or develop interests in nontraditional areas generally pursue careers in these areas more readily; whereas, women who have or develop interests in traditional areas generally do not pursue nontraditional careers (Betz & Hackett, 1981; Betz & Fitzgerald, 1987). Through differential socialization, society might restrict women's interests and interest building experiences, thereby limiting women's career choices and opportunities.

In addition to interests predicting women's selection or non-selection of careers in science, math, and engineering, research has demonstrated that the consideration of a

career in these areas is inhibited by negative attitudes toward math (Chipman et al., 1992) and enhanced by higher interests in math (Chipman et al., 1992; Lefevre et al., 1992; Ware & Lee, 1988). In a study with first-year students, Sells (1980) reported that 57% of the men had completed adequate high school mathematics courses for admittance into college calculus; only eight percent of the women in the sample had completed sufficient high school coursework to qualify for this high level mathematics course. Sells (1980) suggested that high school mathematics coursework was the "critical filter" for women entering nontraditional fields, and she lamented that women's career choices are limited by their inadequate mathematics preparation.

Lips (1992) found that while gender did not affect intentions of enrolling in college science courses, males did intend to enroll in more college mathematics courses than females. Later, the students' actual enrollment partially confirmed their reported intentions; after three years the males in the study had registered for more mathematics and physics courses, the females in the study had registered for more biology courses, and the males and females had registered for chemistry courses in equal numbers. Lips (1992) reported that more men than women in her study cited career goals within the fields of mathematics and science. Indeed, the ratio of men to women choosing science, math, and engineering careers is three to one (NSF, 1994), even when both women and men are taking high level math and science courses (Dick & Rallis, 1991). For example, Lefevre et al. (1992) found that 79% of the women in their study avoided majors that required math despite having completed the same mathematics coursework as men.

While fewer women hold or develop interests in traditionally male areas than in traditionally female areas, it seems intuitive to view such tradition-breaking women as more willing to take risks. However, research has not supported this hypothesis (Douce & Hansen, 1990; Lemkau, 1983). Douce and Hansen (1990) utilized the Strong Interest

Inventory adventurism scale, a measurement of willingness to take risks, to assess the relationship between risk taking and women's nontraditional career choice. Whereas women scoring high in adventurism described themselves as androgynous or masculine, women reporting less interest in risk taking viewed themselves as more feminine. However, despite trends indicating a positive relationship between nontraditional career choice and higher scores on the adventurism scale, a significant relationship was not found between career choice and degree of risk taking.

Performance in Science, Math, and Engineering

Aptitude

Performance on quantitative scales has been examined as it relates to traditional and nontraditional career choice. Whereas Chipman et al. (1992) found that Quantitative Scholastic Aptitude Test (QSAT) scores were not directly related to career choice, much research has shown that aptitude is indeed related to choosing one's career (e.g., O'Brien & Fassinger, 1993; Fassinger, 1990; Singer & Stake, 1986; Goldman & Hewitt, 1976). An early study found that aptitude test scores predicted students' first semester collegiate grade-point averages (Elton & Bate 1966). Ware et al. (1985) determined that outstanding QSAT scores specifically predicted women's selection of scientific majors.

Other researchers have investigated gender differences in aptitude as a possible explanation for women and men pursuing different careers. Some have found that women indeed had lower mathematics American College Testing (ACT) scores than men (Lent et al., 1991; Lapan et al., 1996); similarly, Goldman and Hewitt (1976) reported that men outscored women mathematically on a separate equivalent college entrance exam, the Scholastic Aptitude Test (SAT). In contrast, others have found that there were no significant gender differences in scores on the ACT exam (Adelman, 1994) or on the SAT (Hackett et al., 1992; NSF, 1994).

Childhood testing reveals that between the ages of nine and seventeen, girls' overall scores are similar to boys' overall scores in math proficiency, but girls score lower in science proficiency (NSF, 1994). The gender gap is narrow at general science proficiency, but it widens at the highest level of science in high school, termed "integrating specialized scientific information." At this level, the number of high school boys achieving high scores doubles the number of high school girls receiving comparable scores (NSF, 1994). A similar gap is found with high level math as well (NSF, 1994; Cramer & Oshima, 1992). Other research on children, both pre and post adolescents, has found that among highly gifted children boys tend to score higher than girls on math aptitude measures (e.g., Cramer & Oshima, 1992; Lubinski & Benbow, 1992; Benbow & Stanley, 1980). Gender differences that appear strongest at high levels of ability seem related to the low number of women in areas that require these skills.

Achievement

Achievement gender differences within male-dominated fields have been assessed as a possible reason for women's low numbers in nontraditional areas. College grades are a prime source of achievement assessment, and students might pursue fields in which they receive high academic marks. Several researchers have found that there are no significant gender differences in overall collegiate academic grades (Hackett et al., 1992; House & Wohlt, 1989), and Lefevre et al. (1992) found no gender differences among college students on a test of simple arithmetic abilities.

Yet, in some areas, women's overall academic standings were superior to men's by the end of their high school and college careers. In a sample of students who entered college approximately thirty years ago, Astin (1977) found that women's academic grades in college were higher than men's. Later, Adelman (1994) conducted a fourteen-year longitudinal study of individuals who graduated from high school in 1972. He found that

women's high school academic performance exceeded men's, and this higher level of performance continued in college across curricula. In addition, the women in his study received more college scholarships and completed their degree programs more quickly than their male peers. A longitudinal study involving mathematically precocious children found that by college graduation the female students had achieved higher cumulative grade-point averages than the male students (Benbow & Arjmand, 1980). Also, research has shown that high ability predicted women's entrance into nontraditional fields (Fassinger, 1990).

More recent statistics reported by the National Science Foundation (1994) support Astin's (1977) and Adelman's (1994) findings. For example, in 1991, not only did more women receive bachelor's degrees, but women often graduated with higher grades than men. While 59% of women who received bachelor's degrees graduated with a B average or better, only 47% of men who received bachelor's degrees held this grade-point average (NSF, 1994).

Astin (1977) reported that students who major in engineering, math, or the physical sciences achieve lower grades overall than students in other academic majors. It is possible that the gender differences in academic performance reported by Astin (1977), Adelman (1994), and NSF (1994) are associated with a higher number of men studying engineering, math and the physical sciences. However, in several traditionally male-dominated fields women's percentages of achieving a B average or better were higher than men's percentages. Computer science and mathematics female graduates held a B average nearly two thirds of the time, while less than half of the male graduates held this average. Similarly, 63% of female engineering graduates held a B average, but only 49% of the graduating men did (NSF, 1994).

While women's aptitude scores were generally found to be on par with or lower than men's scores, their achievement scores in relation to men's were, on average, equivalent or

better. Self-selection into majors that are more or less difficult, change of interests, and input from others are factors that may influence career choice and affect gender differences in achievement. Schaefers, Epperson, and Nauta (1997) determined that aptitude and achievement not only are linked to career choice, but high Math ACT scores and high first semester and cumulative grade-point averages predicted retention in engineering for both men and women.

Expectations

Research has investigated the effect of women's expectations on their academic performance and achievement. Nearly thirty years ago Horner (1972) stated that ambitious women were vulnerable to experiencing a "motive to avoid success." The author found that as the women in her study became close to succeeding academically, they became fearful of being viewed as unfeminine following their success. To alleviate this anxiety the women in the study often modified their goals to be more in line with traditional female roles. Horner (1972) suggested that women pursuing nontraditional career fields were particularly vulnerable to this phenomenon, especially when they viewed themselves as competing against men.

Studies have also found gender differences in retention rates related to performance expectations at the college level (Meade, 1991; Ware et al., 1985). Meade (1991) reported that at the University of Washington the mean grade-point average of female engineering students who left their majors was 3.2. Many male undergraduates in that department received letter grades of B and C, yet they continued in engineering (Meade, 1991). In a longitudinal study involving high school valedictorians and salutatorians, Arnold (1993) found that a high number of gifted women withdrew from science and mathematics college majors despite academic records equivalent to or higher than the study's males' records. A panel of highly successful professional women in engineering asserted that the perception

of female engineering students as "super students" puts tremendous pressure on these women (Geppert, 1995). The panelists concurred with Meade's (1991) suggestion that men can persist in engineering despite receiving average grades while women are expected to exhibit exceptional academic performances; this expectation implies that any man can become an engineer, but only extraordinary women can succeed in the field.

Although many researchers have not asked students directly about their grade expectations, investigators have hypothesized that women drop out of nontraditional majors not due to poor grades, but due to high grade expectations that are not met (Meade, 1991; Ware et al., 1985). Men are more likely to remain in male-dominated academic majors despite mediocre grades, but women exhibit different personal expectations. If they do not perform to these standards, they fail their expectations and leave the field. Ware et al.'s (1985) findings indicated that while men with varying SAT scores enter science, math, and engineering, only women with high SAT scores enter these fields. Research has suggested, then, that some women's requirements of superior performance are the result of self doubt (Ware et al., 1985; Seymour, 1995).

In contrast, a study conducted at Iowa State University asked students directly about the relation of their grade expectations with their attrition from engineering majors; the author found no gender differences in grade expectations of those who terminated their majors in male-dominated fields (Schaefers, 1993). Although more research is needed, these findings do not support the "high expectation hypothesis" of Meade (1991) and Ware et al. (1985).

The Relationship of Self-Efficacy and Nontraditional Career Choice

Self-efficacy about performance also contributes to career choice (e.g., Lent et al., 1994; Borget & Gilroy, 1994; Lent et al., 1984, 1986, 1987; Brown, Lent, & Larkin, 1989); in fact, math self-efficacy has been posited as the strongest predictor of academic major

(Hackett & Betz, 1989). Research on self-efficacy has suggested that two principles are important in the discussion of women in nontraditional career paths. First, individuals continue to pursue activities in which they feel confident of their abilities. Second, girls typically are less confident than boys in their ability to succeed at activities perceived as typically male (Bandura, 1986). Based on these findings, much research has concentrated on the relationship of math and science self-efficacy and nontraditional career choice for women (e.g., Borget & Gilroy, 1994; Lent et al., 1991; Lent et al., 1989).

Betz and Hackett (1981) first applied the theory of self-efficacy (Bandura, 1977) to women's nontraditional career choice. They found that undergraduate men reported consistent rates of self-efficacy for all career fields; at the same time, the women in the sample rated their self-efficacy significantly lower for nontraditional than for traditional occupations. Although the study found no gender differences in academic ability, fields highly focused on mathematics and comprised of few women displayed greater divergence in gender self-efficacy beliefs. The field of engineering elicited the greatest difference in self-efficacy ratings between men and women. Whereas 70% of the study's men contended that they could successfully complete engineering degree requirements, only 30% of the women in the sample asserted the same belief. The authors suggested that women's low self-efficacy may limit the range of careers women consider, and it could be caused by a lack of female role models, little encouragement from parents and educators, and few perceived successes. Betz and Hackett's (1981) initial findings that self-efficacy is related to women's nontraditional career choice and that women exhibit lower math self-efficacy than men have been supported by much research (e.g., Betz & Hackett, 1983; Hackett & Betz, 1989; Lent et al., 1991; Lefevre et al., 1992; NSF, 1994).

Lent et al. (1984, 1986, 1987) found that regardless of gender, students with high self-efficacy for completing degree requirements in scientific and technological fields

achieved higher academic grades and persisted in science and engineering majors longer than those who reported low self-efficacy. Similar findings were reported in a study that assessed men's and women's self-efficacy in relation to anagram tests (Hackett & Campbell, 1987). Those administered a difficult anagram test later assessed their self-efficacy with lower scores than those administered a simple anagram test. Although gender differences were not found in the self-efficacy ratings, more women than men who took the difficult anagram test attributed their performance to lack of ability. Women who completed the simple anagram test attributed their performance to luck more often than men in the same test group.

Findings do suggest that increasing math self-efficacy in women could influence the number of women who consider themselves able to succeed in nontraditional careers (Chipman et al., 1992). Girls in primary and secondary educational settings demonstrated self-defeating causal attributions toward math performance more often than boys (Cramer & Oshima, 1992), and this phenomenon continued into adulthood (Temple & Lips, 1989). Hackett (1985) reported that gender and gender socialization in addition to previous math preparation and achievement influenced math self-efficacy. In turn, math self-efficacy predicted math anxiety and academic major. Arnold (1993) found that male and female high school valedictorians and salutatorians assessed their intelligence similarly at their high school graduations. By the second year of college, however, women's assessments of their own intelligence had decreased while men's self assessments had remained stable. Temple and Lips (1989) found that although women make self deprecatory statements, they do not view their entire gender as inferior. They concur with Collis (1985) that a common belief among women is, "We can, but I can't."

Research has shown that high self-efficacy predicted women's success and persistence in college and in the workplace (Borget & Gilroy, 1994; Brown et al., 1989).

Hackett et al. (1992) found that high self-efficacy resulting from achieving academic milestones within one's program of study was the strongest predictor of performance for engineering students. In the same study, high interests, positive outcome expectations, and strong faculty encouragement positively predicted high self-efficacy in both men and women. Research conducted by Lent et al. (1991) found that high self-efficacy was predicted by strong performance, high social persuasion, low emotional arousal, and elevated math ACT scores. These findings are helpful in identifying a number of variables related to women's self-efficacy in pursuing nontraditional careers; unfortunately, the lack of longitudinal studies in this area make it difficult to determine what interventions should concentrate on to best attract and retain women in science, math, and engineering.

External Barriers to Women Studying Science and Engineering

Potential Value and Role Conflicts

Prior to entering the workforce, the timing of marriage and motherhood is an issue many women confront (Eccles, 1987). Students in college have predicted that personal lives and careers will be difficult to merge (Swanson & Tokar, 1991; Morgan, 1992), and research has shown that women with high family priorities were less likely to major in a scientific field (Ware & Lee, 1988). Many feel pressed to choose whether to work in a nontraditional occupation or one with a higher percentage of women and working mothers, a presumably more supportive environment. Women continue to receive messages after entering the workforce that suggest integrating a career and a family is difficult (Reddin, 1997).

In a longitudinal study of high school valedictorians and salutatorians, Arnold (1993) discovered that while women were concerned with future role conflicts and two-thirds eventually planned to leave their careers temporarily to raise children, men had little concern about experiencing role difficulties. Additionally, Schroeder, Blood, and Maluso

(1993) found that men anticipated less role conflict for their future wives than women predicted for themselves. In particular, this study highlighted different lifestyle perceptions between the genders; whereas only six percent of the women anticipated permanent withdrawal from the labor market following childbirth, 50% of the men predicted this lifestyle for their future partners.

The potential ramifications for women in nontraditional careers temporarily dropping out of their professions to raise children, which two-thirds of the women in Arnold's (1993) study planned, can include removing themselves from opportunities for professional enhancement and job promotions. Not surprisingly, women can become discouraged and terminate their careers in nontraditional fields. Women's attrition rate is twice that of men in male-dominated fields (National Research Council's Committee on Women in Science and Engineering, 1994), and Arnold (1993) found that ten years after high school graduation only 50% of the high achieving female valedictorians and salutatorians remained in male dominated professions, compared to 80% of the men. The author reported that attrition at all educational levels often occurred because of women's beliefs that they would be unable to successfully combine their careers with their roles as wives and mothers.

Other research found that women were less concerned than men about the difficulties women face in combining personal lives and careers. Also, some women have less traditional views about women working outside of the home than do men, and many women generally believe that they can successfully integrate the two opportunities (Lips, 1992; Sullivan, 1992; Lemkau, 1983). Research showed that women who delay childbearing are in more highly educated and higher paying occupations (Arnold, 1993; Card, Steel, & Abeles, 1980). Also, women in nontraditional majors tend to hold less traditional views on gender roles (Houser & Garvey, 1985; Fassinger, 1990), and women with egalitarian attitudes demonstrated higher academic achievement in nontraditional

programs of study than women espousing traditional gender role attitudes (Chatterjee & McCarrey, 1989). Another study stated that women who had integrated their careers and their families, regardless of the traditionality of their career fields, were more satisfied with their careers than single women in the workforce and were more satisfied with their family lives than full-time homemakers (Rodenstein & Glickauf-Hughes, 1979). These women reported that mental stability and support from others in their lives were integral to the successful integration of their careers and personal lives.

In sum, these findings lend only moderate support for the idea that women avoid nontraditional careers because of their concerns about mixing career and family (Lips, 1992). While women believe that they can combine family with career, they might not feel confident that all environments will be cooperative and supportive of this choice.

Social Support

Several researchers have studied the effect of social support on women's choices to study nontraditional academic majors (Freeman, 1979; Meade, 1991; Dick & Rallis, 1991; Hackett et al., 1992; Betz & Fitzgerald, 1987). Educators are one group of important individuals to whom students turn for support. One of the strongest predictors of career salience and high educational goals was positive female teacher influence for one sample of college female graduating seniors (Hackett et al., 1989). Dick and Rallis (1991) also noted the significance of educators as they found that teachers were more influential for high school women who were planning a science or engineering career path than for high school women who were planning a more traditional career course. Yet, the influence of teachers does not always support women entering male-dominated careers.

One study found that high school women who were influenced in collegiate planning by high school educators were less likely to take high school math and science courses and were less likely to major in science during post secondary education (Ware & Lee, 1988).

In a related finding, Meade (1991) reported that 80% of surveyed female engineers stated that the lack of school counselor encouragement to pursue engineering careers is the primary reason for the low numbers of women in engineering. A small sample of women employed in nontraditional careers agreed that their teachers and guidance counselors were often unavailable or unsupportive in the students' career decision making (Reddin, 1997). Research in this area has indicated that while educator support can have either a positive or negative influence for women pursuing nontraditional careers, parental influence has produced positive effects on women's nontraditional career choice.

Betz and Fitzgerald's (1987) review of the literature found that high parental support was an important factor both for women planning for and engaging in nontraditional careers. Additionally, higher parental academic expectations were reported by women pursuing nontraditional careers than by those pursuing traditional ones. The authors asserted the results should be reviewed with caution, as the majority of the research on parental support for nontraditional women is based on data collected from nuclear families, a phenomenon occurring with decreasing frequency (Betz & Fitzgerald, 1987). Yet, while different amounts and sources of support are possible between intact and divided families, it seems likely that the importance of parental support itself would remain high regardless of the family's living arrangements.

Houser and Garvey (1983) reported that over 60% of their sample's women in nontraditional majors reported encouragement from their parents to enter a nontraditional field, while only 19% of women in traditional majors reported this same encouragement. Additionally, 48% of the women in nontraditional fields had been told that they would succeed in nontraditional coursework in contrast to 14% of women in traditional majors and 27% of women who considered a nontraditional major but instead entered a traditional field.

Students also depend on their peers for social support, and a general study on college attrition found that males who withdrew from the university reported fewer friends within their first month on campus than students who persisted at college (Simpson, Baker, & Mellinger, 1980). Another study indicated that students felt that "meeting people in my field" was the most important factor in maintaining their current academic majors (Keller et al., 1990), and women in nontraditional majors reported that, following parental support, girlfriends had the greatest positive influence on women's pursuit of nontraditional careers (Houser & Garvey, 1983; Casserly, 1979). Indeed, Houser and Garvey (1983, 1985) stated that women in nontraditional majors perceived more social support than women in traditional majors, and the amount of positive support and encouragement received from others best differentiated women who chose nontraditional majors from those who entered traditional fields.

Role Models

It makes intuitive sense that women contemplating nontraditional careers would look for role models to emulate, and Ivey (1988) suggested that young women studying science and engineering need encouragement and guidance from experienced women in nontraditional fields. Daniels (1988), the director of a university program for women in engineering, proposed that women in engineering gain the most realistic expectations from ordinary individuals with whom the women interact rather than from "superstars" in their fields. Indeed, research has indicated that female engineers are more likely to have a father in the scientific or engineering fields (Fitzpatrick & Silverman, 1989; Anderson, 1995), that at least 50% of all female engineers are related to an engineer (Meade, 1991; Greenfield, Holloway, & Remus, 1982), and that highly educated parents are positively related to daughters selecting scientific careers (Ware et al., 1985; Greenfield et al., 1982).

Based on their review of the literature, Betz and Fitzgerald (1987) suggested that high parental education achievement is an important role modeling factor for encouraging women's nontraditional career choice. Further, they concluded daughters are more likely to be career oriented, follow nontraditional career paths, and hold more liberal sex-role expectations when their mothers work outside of the home. Similarly, Houser and Garvey (1985) found that the mothers of women in nontraditional majors were employed for more years than the mothers of women who had considered nontraditional majors but instead had entered traditional fields; at the same time, other research has contradicted this finding (Fitzpatrick & Silverman, 1989).

A study on the effects of tutoring for introductory college math and science courses provided information on peer role models (House & Wohlt, 1989). Tutees performed significantly better in the courses when they worked with same-gender tutors. The authors hypothesized that same-gender tutors are able to disperse the information in a more understandable context, are easier to relate to, and serve as role models. This finding suggests that students might perform better with same-gender instructors. However, only 3% of all U.S. engineering faculty are women (NSF, 1994), and female engineering students only rarely have an opportunity to work with same-gender instructors (Geppert, 1995). At the same time, Dick and Rallis (1991) discovered that women who choose and complete science and engineering majors are more similar to their male classmates than to women in other majors; this might lend hope to the idea that women in nontraditional fields can gain support from opposite-gender peers and faculty.

Hackett et al. (1989) found that positive role model influences were predictive of women's high career goals and educational choices, but they did not find gender differences in role modeling as they had expected. Female teachers and mothers were hypothesized to play a greater role than men in influencing women's career salience, goals,

and nontraditional career choice, yet male role models were equally influential. In nontraditional career choice this could occur because the majority of people in nontraditional careers are men. When there are few women to emulate, men are alternative models.

Even after entering the workforce, women gain support and encouragement from role models (Reddin, 1997). In a study of female attrition within technological fields cited by the National Research Council's Committee on Women in Science and Engineering (1994), successful women in science and engineering reported using mentors throughout their careers. These women posited that, regardless of the mentor's gender, it is important to secure supportive role models for women as they assimilate into male-dominated fields.

Null Academic Environment

Women are minorities in and relative newcomers to traditionally male-dominated careers and some have reported overt sexual discrimination and harassment (Giurleo, 1997; Geppert, 1995). While some women reported that faculty were purposefully discriminatory, others felt that faculty were simply ignorant in their clumsy use of insensitive language and modes of thinking (Seymour, 1995; Freeman, 1979). These women stated that such daily stressors continually wore down their desires to persist in nontraditional fields.

Several researchers have asserted that women in nontraditional academic majors experience "stereotype threat," a phenomenon that suggests women performing math-related activities fear they will be judged negatively by the societal stereotype that men's math abilities exceed women's math abilities (Spencer et al., 1999; Brown & Josephs, 1999). Spencer et al. (1999) conducted multiple studies investigating the effects of "stereotype threat" on women performing advanced mathematical problems. Results indicated no gender differences in ability when the female participants experienced no "stereotype threat," but the women's performance deteriorated when they perceived a

potential "stereotype threat." The authors concluded that women experience a "self-threat" when they perceive that they will be judged based on society's stereotypes of women pursuing nontraditional careers. This internal threat may lead women to question their abilities and consequently abandon their chosen fields. Brown and Josephs' (1999) results supported the findings of Spencer et al. (1999) and suggested that "stereotype threat" interferes with women performing capably because they are overly concerned with negative outcomes.

Other research has shown that women seek reassurance regarding their academic performance from their professors (Seymour, 1995). Women in this study tended to search for encouragement and they perceived a lack of positive accolades as the professor's dissatisfaction with the students' performance. Freeman (1979) reported similar findings and she and Betz (1989) credited a null academic environment with subtly discouraging women from pursuing nontraditional occupations. Freeman (1979) defined the null environment as "an academic situation that neither encourages nor discourages students of either sex" (p. 198). She further argued that the null environment "is inherently discriminatory against women because it fails to take into account the differentiating external environments from which women and men students come" (p. 198).

Anderson (1995) reported that 30% of the female engineering students in her sample felt that their professors did not care about them. Additionally, the author asserted that the majority of women in engineering majors feel that faculty and administrators do not demonstrate interest in the students or recognize their academic efforts. Freeman's (1979) finding that both genders reported feeling ignored by their professors underscores the reality of this environment. Ultimately, she argued, the failure of faculty to encourage women to seek nontraditional careers results in unplanned discrimination.

Freeman (1979) continued her discussion on the "null environment" with the statement that "professors don't have to make a specific point to discourage their female students. Society will do that job for them. All they have to do is to fail to encourage them. Professors can discriminate against women without really trying" (p. 198). The author concluded that professors who are oblivious to this occurrence are detrimental to women pursuing nontraditional careers. The finding by Hackett et al. (1992) that occupational and career self-efficacy and performance were associated with perceived faculty support indicates the influence professors have on their students. The societal messages women receive from those around them about nontraditional careers and the implications of the null environment indicate that professors of science and engineering may unknowingly discriminate against women and discourage them from seeking nontraditional majors and occupations (Betz, 1989). Some might argue that these actions do not constitute discrimination, but most would agree that they represent missed opportunities to encourage and develop talented young women as scientists and engineers.

Although Hackett et al.'s (1992) findings differ from the "null environment" in that male engineering students in their sample reported significantly more support from faculty than did their female cohorts, the authors confirmed that women have a less favorable educational experience than men in male dominated areas. While other factors may contribute to women's less favorable academic experience, the authors' call for more supportive collegiate programs indicates the need for the kind of interventions investigated in the present study. Indeed, Betz (1989) suggested that without taking an active role in supporting women in nontraditional majors, educators and social scientists could inadvertently contribute to the null academic environment.

External Barriers in the Workplace

The Culture of Engineering

Because women are underrepresented in university science and engineering programs, they are also a minority in these professions. Robinson and McIlwee (1989, 1991) argued that the struggle for women in these fields does not end once they have gained employment. They described a "culture of engineering" in the workplace that values traditionally male traits and discounts traditionally female traits. The authors suggested that the "culture of engineering" discriminates against women, which hinders their opportunity to achieve positions with greater compensation and recognition. Three components comprise this "culture of engineering" according to Robinson and McIlwee (1989, 1991). The first is the emphasis placed on "technological tinkering," defined as fascination with hands-on activities in the course of developing a product. The authors suggested that men are acculturated to participate in "technological tinkering" from an early age, and their continuation of this activity in the workplace distinguishes them from women who have entered the engineering profession for reasons other than "tinkering." Empirical support of this component is found in a study by Temple and Lips (1989), who reported that men and women in computer science did not differ in their professional computer use but that men reported more use of computers in their leisure time.

A second component of the "culture of engineering" is explained as organizational power. In addition to an inclination toward "technological tinkering," Robinson and McIlwee (1989, 1991) argued that engineers also seek the esteem that comes with managerial promotions. Such promotions provide higher status and greater power, and they are aggressively pursued. The assertiveness required to obtain these positions can be discomforting for some. Due to sex-role stereotypes characteristic of both the culture and the job market, and the fear of being ostracized from both their coworkers and the

promotion process, such assertiveness can be especially daunting for women. Presumably, this partially explains the fact that proportionately fewer women are found in management positions in engineering (Robinson and McIlwee, 1989, 1991). Again, this lack of participation in the managerial process reduces the status, authority, and salary of women in these fields.

The final component of the "culture of engineering" is the interaction among engineering coworkers. Robinson and McIlwee (1989, 1991) stated that acclimation to the workplace requires one to look, talk, and act like an engineer, as defined by the majority group. Women demonstrate less assertiveness and self-confidence, which are related to lower job status. The authors stated, "Men may not be better engineers, but they are better at appearing to be better engineers" (1989, p. 465).

These three components result from a fusion of masculine characteristics and legitimate engineering skills and make it difficult for women to be perceived as engineers by male coworkers. Women experience difficulty being accepted as intellectual, capable colleagues in a male-centered engineering culture, and one researcher related several ways in which women have been objectified within the field of engineering (Hacker, 1981). A quondam engineering magazine published at Iowa State University, *The Iowa Engineer*, included a centerfold picture entitled "E-Girl of the Month" and a dirty joke page in each issue. Also, at professional conventions female models have staffed merchandise booths wearing bunny suits or other suggestive clothing. Finally, the author related that an agricultural engineering promotional booth once sported a female mannequin with a sign on its behind that stated, "Ag Engineering, for a BROAD education."

Hacker (1981) argued that such messages reinforce the culture of engineering and, perhaps most detrimental, teach young male engineers that such behavior is acceptable. Robinson and McIlwee (1989, 1991) argued that the net effect of these messages and the

components of the culture of engineering is to discourage women from entering engineering, relegate women to lower status positions, and discourage women from persisting in the field.

Discrimination and Gender Differentiation

The aforementioned description of the "culture of engineering," derived from research performed by Robinson and McIlwee (1989, 1991), has implications for discrimination and gender differentiation on the job. The National Research Council's Committee on Women in Science and Engineering (1994) found that women in nontraditional fields encounter limited access to opportunities and experience paternalism and condescension from men within the workplace. Robinson and McIlwee (1989, 1991) reported that in addition to holding lower status positions and being less likely to be promoted to important managerial positions, women also are demoted more often than are men. Although there were no control measures for ability used in their studies, the authors did investigate prior academic performance as it might affect those being surveyed. In their sample of recent engineering bachelor's degree recipients from two universities, women, on average, achieved higher grade-point averages than men and were overrepresented in the engineering honor societies (Robinson & McIlwee, 1989, 1991).

Robinson and McIlwee (1989, 1991) also found that women are discriminated against more often and are provided fewer advancement opportunities in electrical/electronic engineering and high-tech (defined as producing "sophisticated engineering technologies," 1989, p. 459) areas of engineering, as opposed to aerospace engineering and mechanical engineering. This is unexpected because electrical/electronic and high-tech engineering are newer fields and often hire younger engineers. The authors hypothesized that the older, more stable areas of engineering, aerospace engineering and mechanical engineering, have been more affected by affirmative action requiring equal

representation within the company hierarchies. Although affirmative action has been somewhat helpful in opening the doors for women to enter male-dominated fields, knowledge of past prejudice serves as a continuous subtle reminder that women are outsiders (Koshland, 1988). Given these findings, it is understandable that Geppert (1995) asserted that "while a man considers engineering to be a career, a woman – to be successful – must also consider it to be a crusade" (p. 40).

Potential Interventions to Assist Women in Nontraditional Career Paths

Women's low numbers in traditionally male fields and the aforementioned barriers believed to hinder women's entrance into these areas have prompted interest in possible interventions at the collegiate level. Supportive programs for women in nontraditional majors have been established at universities across the nation in response to this situation. Some of these programs are student-run organizations, such as the Society of Women Engineers (SWE) and the Association for Women in Science (AWIS), and many institutions provide funding for administrative programs aimed at encouraging and supporting women in nontraditional fields.

Women in nontraditional majors may benefit from many interventions offered for the general student population. Such programs range from departmental tutoring programs to coordinated learning teams, or they can include more complex interventions combining residential and educational aspects of university life. The latter interventions group members of a particular major, age, ability level, and/or gender together and capitalize on peer influence to accomplish the university's academic goals (Adams, 1974; Pascarella et al., 1994). Academic support, social services, special programming, and a social network of similar individuals are offered to these groups to assist members in achieving academic, social, and/or personal goals (Pascarella et al., 1994).

Interventions combining students' living and learning environments are categorized most often as either Living Learning Centers (LLCs) or Residential Colleges (RCs) depending on the intervention's attributes. Despite the straightforward titles of these interventions, the categorization of specific programs has been hindered by the lack of operational program definitions. This has caused confusion among administrators and reduced accurate distinctions among programs with disparate attributes (Rowe, 1979). Imprecise program definitions have limited accurate program evaluations of the interventions (Schroeder & Freesh, 1977; Rowe, 1979) and have, in turn, reduced the number of institutions that have initiated such programs (Rowe, 1979). College administrators launched a Task Force on Living Learning Centers in 1977 aimed at establishing a single definition for the living learning center concept (Rowe, 1979). Task Force members derived the following definition for LLCs while acknowledging that not all programs would include every aspect of the definition:

> A living learning center is a residence unit which seeks to integrate the student's academic experience with her or his living environment. The goals of affective, cognitive, and physical growth and development of the resident are pursued through intentional provision of formal and/or informal (credit and non-credit) learning experiences. Unlike a residential college, the LLC is not a degree-granting entity. Student residence within the LLC is voluntary, contingent upon some form of application/selection process. Academic support as well as student affairs support is provided for the LLC and may include facilities, services, on-going faculty participation and/or a programming budget. (Rowe, 1979, p. 24)

The Task Force stated that RCs differ from LLCs by granting degrees, providing for the residents nearly all required academic courses within the housing structure, and housing faculty who live, teach, and maintain offices within the residence (Rowe, 1979). Due to practical limitations of existing housing structures and faculty availability, few collegiate living and learning interventions utilize an RC model, instead favoring an LLC model.

Evaluating Residential Interventions

Intuitively, LLCs appear helpful, yet it remains important to systematically evaluate these interventions to determine their utility and validity with specific populations. In their book discussing effective evaluation strategies of programs for women in science and math, Davis and Humphreys (1985) stated that evaluating interventions can enhance existing programs and enccurage additional initiatives. More specifically, the authors suggested that program evaluations provide knowledge, aid in program planning, identify and record positive and negative program attributes, promote public awareness, and attract additional funding.

Two research designs, randomized and quasi-experimental, are possible when studying residence hall living effects on students (Pascarella et al., 1994). Randomized experiments require that the research participants are distributed across situations unsystematically. This allows participant academic and personality traits to be spread across all groups. A randomized design, resistant to confounding variables, is often preferred in research, but it is nearly impossible to use with this population. Few students will allow university administrators to choose the students' living arrangements, and it has been asserted that assigning students to living quarters without their informed consent is unethical (Schroeder, 1980).

More often, quasi-experimental or correlational research designs are employed when studying LLC programs. Students self-select into the experimental group by replying to correspondence inviting their participation in the LLC on a first-come, first-served basis (e.g., Taylor & Hanson, 1971; Schroeder & Belmonte, 1979; Kanoy & Bruhn, 1996), and researchers use statistical methods to reduce the effects of extraneous factors (Pascarella et al., 1994).

A significant amount of research has been conducted on residential communities that include educational components (Pascarella et al., 1994). Initial research in this area emanated from studies that investigated differences between residence hall students and commuter students. More recent studies have evaluated the effects of residential communities on participant academics, retention, and personal development (e.g., Williams & Reilley, 1972, 1974; Williams et al., 1980; Blimling, 1993).

LLCs and Academic Life

Research has shown that emphasizing studying and academic achievement on residence hall floors can significantly increase the academic performance of the floor members (Astin, 1977; Blimling & Hample, 1979; Golden & Smith, 1983). Several researchers have found that after taking pre-enrollment differences into account, first-year students in LLCs achieved significantly higher academic standing than freshmen in traditional residence hall living arrangements (Pascarella & Terenzini, 1981; Schroeder & Griffin, 1976; Taylor & Hanson, 1971; Crew & Giblette, 1965).

An early study in the area of roommates and academic life found that roommate pairs who were enrolled in an elementary mathematical analysis course attained grades higher than predicted by their ACT scores (Crew & Giblette, 1965). A similar trend was found in an English course and an algebra course, though two other courses did not produce this trend. Although the findings were not entirely generalizable, the authors contended that living environment proximity can affect academic performance. Morishima (1966) randomly assigned male students with similar majors to either an LLC or a control group. He found that members of the experimental group tended to achieve higher grade-point averages than members of the control group, though the differences were not statistically significant. The groups did not differ in the number of members who changed their academic majors.

More recently, Kanoy and Bruhn (1996) found that first-year women living in an LLC attained higher grade-point averages than a matched control group of women housed on other residence hall floors. These differences remained throughout the four academic semesters the groups were studied, with significant differences found in the first two academic semesters. Further analyses indicated that LLC members attained higher grade-point averages than predicted by their college entrance exams; at the same time, the control group achieved lower grade-point averages than expected. As Crew and Giblette (1965) had stated thirty years earlier, Kanoy and Bruhn (1996) asserted that propinquity of housing affected academic achievement.

Other research in residential communities has focused on specific student populations. DeCoster (1966, 1968) conducted a two year study of high ability students in an LLC. The project investigated differences between high ability students (students in the upper 90^{th} percentile at a large university) residing in the same housing unit, high ability students randomly assigned to other housing units, general ability students residing in the unit with the high ability LLC students, and general ability students who were randomly assigned to other campus housing units. At the conclusion of the first year, the groups demonstrated no significant differences in academic performance. The concentration of high ability students in the LLC was raised from 25% to 50% the following academic year, and the high ability LLC residents attained higher academic scores than their high ability cohorts who had been housed randomly. Other research has supported DeCoster's (1966, 1968) findings on the effects of LLCs with high ability students. In an investigation of high ability "President's Scholars" (membership criteria included having achieved an ACT composite score of 28 and a high school rank within the upper 10% of the graduating class), Duncan and Stoner (1976) demonstrated a nonsignificant trend that students living

within an LLC achieved higher academic grades than students living at home, in off-campus housing, or in other residence halls.

Further analyses of DeCoster's (1966, 1968) data produced additional findings on the effects of LLCs within the student population. The author noted that gender played a role in group differences. High ability women housed in the LLC performed significantly better academically than women in the control groups; at the same time, high ability men posted a non-significant trend in higher academic performance over the men in the control groups. The author concluded that female students in this study appeared to be more affected academically by homogenous living arrangements than the men in the study (DeCoster, 1968). Although differences were not expected between the two general ability student populations, those living on the LLC with the high ability students attained lower course grades than the general ability students who had been randomly assigned to other housing units. The author suggested that the high ability students housed in the LLC negatively affected the academic performance of the other unit residents (DeCoster, 1966). At the same time, Snead and Caple (1971) found that within an LLC based on academic major the majority group (residence hall members with the same academic major) did not negatively affect the minority group (members with dissimilar academic majors) in academic performance.

Research has been conducted on the effects of LLCs with students in traditionally male-dominated majors also. A study conducted nearly 30 years ago investigated differences in academic performance among first-year males studying engineering who either lived in an LLC, lived in other campus housing units, or commuted to campus (Taylor & Hanson, 1971). The results indicated that with no prior significant differences in the samples, a higher percentage of LLC members attained grade-point averages of at least 2.00 when compared to members of the other two groups. Also, these researchers found

that even for those who transferred out of engineering, the LLC members averaged a higher grade-point average than the students living in other campus residence halls or the students who commuted. In a similar study, Schroeder and Griffin (1976) found that male freshmen engineering majors living in an LLC achieved significantly higher first year grade-point averages than other freshmen engineering majors not living in an LLC.

A review of the literature revealed the paucity of research conducted in the area of LLCs for women in nontraditional fields. It is possible that studies in this area are rare because the small numbers in this population have precluded extensive investigation. One study, performed twenty years ago, began to fill this void (Schroeder & Belmonte, 1979). Forty-seven first-year female students in pre-pharmacy were invited to participate in an LLC; of the twenty-two who responded, fourteen were randomly selected as LLC members. Fourteen first-year women studying pre-pharmacy living in other campus housing units, including four students who had volunteered for the LLC, comprised the control group. Despite no differences in high school grade-point averages or college entrance exam scores between the groups, the authors found that the members of the LLC attained a higher grade-point average than the control group after the first two quarters of the academic year.

Other research has suggested that LLCs do not facilitate higher academic achievement over standard residence hall floors. Thirty years ago Elton and Bate (1966) contended that no significant differences in grade-point average existed between first-year roommate pairs with identical academic majors and first-year roommate pairs with dissimilar majors. These authors asserted that 83% of the variance between the two groups could be explained by ability. Other research has indicated that LLCs do not improve grade-point averages among arts and sciences students (Pemberton, 1969), general first-year students (Barnes, 1977), male engineering students (McKelfresh, 1980), and honors students

(Stewart, 1980) when LLC members were compared with members of control groups. Two longitudinal studies found that LLCs appeared to have little influence on cumulative grade-point averages throughout the collegiate experience (Felver, 1983; Goldman & Dickerson, 1993).

Although research on the academic effectiveness of LLCs has produced mixed results, continuous published research evaluating LLCs demonstrates the enduring interest in these programs. Program implementers may have noted the volume of published studies supporting the academic effectiveness of LLCs or they may have found LLCs intuitively appealing. Whatever the reasons for initiating these interventions, program evaluations of LLCs would not be complete without assessing the effect of LLCs on student retention.

LLCs and Retention

In his comprehensive literature review, Blimling (1993) indicated that students who are members of LLCs persist in college more frequently than students who live in traditional residence halls. An early study by Morishima (1966), in which he randomly assigned incoming students with similar majors to an LLC or to a control group, found that fewer members of the LLC withdrew from the university during their first two years of college. Vander Wall (1972) reported similar results when he found that twice the number of LLC members than control group members successfully completed their first year of college.

Among high-ability students, DeCoster (1966, 1968) found a non-significant trend indicating that students in an LLC were less likely to withdraw from the university than their control group cohorts. Also, the author reported that general ability students residing with the high ability students exhibited twice the withdrawal rate as general ability students housed randomly. The high ability students appeared to negatively affect the retention rate of others within the LLC. Brown (1986) studied concentration effects on retention within LLCs. He grouped high numbers of science majors with low numbers of humanities majors

on one LLC residence hall floor and reversed the concentration of these majors on a second LLC residence hall floor. After comparing the groups, he found that significantly more members of the minority groups changed their academic majors to match the curricula of the majority group members. Further, Brown (1986) asserted that members of the minority groups who did not change their majors expressed greater uncertainty in their programs of study during the academic year.

Several studies have demonstrated that LLCs can assist in both university and curriculum retention (e.g., Chapple, 1984; Pascarella & Terenzini, 1980, 1981; Schroeder & Griffin, 1976). Chapple's (1984) study found that after two years in college, 55% of science majors who were housed in close proximity to other science majors were still in their original departments, while only 37% of science majors who were housed randomly remained in their original departments. A significant difference was found in university retention also. While 81% of the science majors who lived in close proximity to other science majors remained at the same institution, only 67% of the science majors who were housed randomly remained (Chapple, 1984).

Schroeder and Griffin (1976) found similar but more extreme differences. Their study, analyzing male engineering students after two years of participation in an LLC, found that 70% of the members in the LLC were still enrolled in engineering, while only 51% of male engineering students who did not live in the LLC remained in their engineering curricula. Another study investigating female pre-pharmacy students within an LLC found that following the first year of college, 75% of the LLC members remained in the pre-pharmacy academic major compared with 50% of the control group members (Schroeder & Belmonte, 1979).

Felver (1983) conducted a longitudinal study investigating five LLCs based on academic majors located on a university campus. The five LLCs, for students majoring in

business, foreign language, music, pre-law/political science/ public affairs, and students in the honors program, were assessed over a four year period and compared with matched academic major control groups. The author found that except for the music major LLC, all of the LLCs had higher graduation rates and program of study retention after four years than the control groups.

Other research has produced conflicting results. Taylor and Hanson (1971) failed to find significantly different retention rates between members of LLCs and control groups. Also, contrary to his hypothesis, DeCoster (1968) found that more female LLC members than female control group members withdrew from the university; at the same time, this difference was not found between the male LLC and control group members. Another study suggested that while retention rates were not significantly different between groups of first-year women, the LLC members exhibited a 79% retention rate compared with only a 63% retention rate among the members of the control group (Kanoy & Bruhn, 1996). These studies dispute the idea that the social and academic sharing in the LLC are catalysts for the members' increased retention; at the same time, these conflicting results are found less frequently in published research than findings suggesting retention is aided by LLC membership.

LLCs and Personal Development

In addition to academic performance and retention, program administrators evaluate the effects of LLCs on student personal development and environment perceptions. Studies have found that students who participated in LLCs were more satisfied with their personal achievements (Schroeder, 1980), more involved in other campus extracurricular activities (Schroeder & Griffin, 1976; Madson et al., 1976; Magnarella, 1975; McKelfresh, 1980), more pleased with their living environment (Schroeder & Griffin, 1976; Pascarella & Terenzini, 1980; DeCoster, 1968; Madson et al., 1976; Arminio, 1994; Magnarella, 1975;

Golden & Smith, 1983), and more satisfied with their academic program (Pascarella & Terenzini, 1981; Pemberton, 1969; McKelfresh, 1980) than other students sampled who lived in traditional residence halls.

Other studies have suggested that LLCs affect students' lives positively and negatively. Magnarella (1975) reported that while members of the LLC were more pleased with their living environment, educational atmosphere and opportunities, and extracurricular activities, they stated that their housing unit was poor in community spirit. Also, Centra (1968) indicated that LLC members felt their housing unit was friendly and cohesive, but they did not view the LLC as more intellectually focused than traditional residence halls. Finally, Barnes (1977) found no differences between members of an LLC and a control group in interpersonal growth and skills, study skill self-efficacy, and communication skill self-confidence.

The academic atmosphere found in LLCs aids members in higher academic achievement; at the same time this environment can be perceived by LLC members as highly competitive. Schroeder and Belmonte (1979) noted in their study of female students majoring in pre-pharmacy that members of the LLC reported significantly higher academic competitiveness on the residence hall floor than members of the control group. These findings were supported by Golden and Smith (1983) who found that 33% more of "study floor" members than "non-study floor" group members reported academic competitiveness on their residence hall floor.

Studies reporting high student retention within the LLC can imply student environmental satisfaction. DeCoster (1968) reported that significantly more LLC members than control group members filed requests to remain on the same residence hall floor for a second year. Morishima (1966) found that members of an LLC based on academic major remained on their residence hall floor or within campus housing more frequently than

members of a control group. In a study involving male engineering students, 50% of those in the LLC group still lived in a university dormitory after two years, while only 26% of those not in the LLC still resided in the residence halls (Schroeder and Griffin, 1976).

Schroeder and Belmonte (1979) reported similar results in their study of female pre-pharmacy students. Eighty-six percent of the members of the LLC remained on the same residence hall floor, whereas only 64% of the matched control group remained on the originally assigned floor. Additionally, members of the LLC reported that 81% of their friends were on their residence hall floor; at the same time, the control group indicated that 53% of their friends were on their residence hall floor. In a subsequent publication based on the Schroeder and Belmonte (1979) study, Schroeder (1980) concluded that the LLC promoted peer interaction, aided students' intellectual self-perceptions, and decreased students' negative affect.

Two longitudinal studies provide support for these findings. Felver (1983) found that a higher percentage of members in five academic LLCs remained in campus housing when compared with members of control groups. Another study reported that a significantly higher percentage of LLC members than control group members remained on the same residence hall floor for two years in two separate cohorts of students (Goldman & Hood, 1995). At the same time, these researchers indicated that a larger number of LLC members than control group members showed interest in transferring from their small college to a larger institution. While transferring institutions may indicate dissatisfaction, it may also suggest that the LLC students felt empowered to compete academically in a larger educational environment.

Implications

Investigations into the effectiveness of LLCs have prompted contemplation of program implications. Pascarella et al. (1994) recognized that grouping members of a

particular persuasion by curriculum, achievement, or gender decreases diversity and leaves few role models in traditional residence hall settings for others to emulate. Additionally, those who are attracted to certain LLCs might naturally be more likely to thrive in the particular unit. Quasi-experimental designs are almost always used, allowing participant self-selection, which can skew study results (Pascarella et al., 1994; Blimling & Hample, 1979).

Of particular interest to university administrators are the results regarding retention. Chapple (1984) determined that the retention of just 20 members of his 146 participant sample of a small New York college could generate well over $100,000 per year in college tuition revenue. He concluded that programs like LLCs are helpful to students and administrators. Students are more likely to remain in their original department which allows them to attain their education more efficiently. Implications for universities include more tuition revenue, more stable enrollments, higher retention resulting in fewer recruitment pressures, and increased consumer satisfaction. His unstated conclusion ponders why administrators would not institute such programs to receive even one of the benefits mentioned above.

The Need for Intervention Programs

Several researchers have suggested that interventions should be implemented aimed at encouraging students, women in particular, to pursue and complete college degrees in science and engineering. Bickart (1991), an engineering dean, asserted that interventions must be developed at the collegiate level to support engineering students as they enter and continue their degree programs. Additionally, he posited that first-year entry programs should be implemented that introduce students to supportive academic and peer advisors and foster peer study and support groups. The author also promoted the use of

study centers that facilitate collaborative learning and provide tutoring to optimize academic achievement.

Specific to encouraging women studying nontraditional academic majors, Ivey (1988) suggested that providing a "critical mass" of female peers studying science and engineering is integral to recruiting and retaining women in these nontraditional fields. The suggestion of a "critical mass" was supported in Geppert's (1995) documentation of a roundtable discussion with highly successful women in engineering. The discussants asserted that although women's percentages in engineering are slowly increasing, women still feel isolated because they are spread throughout the field in small numbers. They contended that universities and faculty need to provide interventions to facilitate women's interactions. Daniels (1988) concurred that personal contact between women studying engineering and their peers was the most effective way to support students. She also advocated interactions with university staff invested in women's nontraditional field achievement. The author suggested that a variety of outreach initiatives is important because women are attracted to diverse programs. As the director of a program for women studying engineering, Daniels (1988) posited that universities with strong interests and strategies for enabling women to succeed will better attract women to their institutions resulting in greater recruitment, retention, and tuition revenue.

LLC interventions for women in science and engineering have been instituted at a number of prominent universities in the nation, with the first beginning in 1989 at Rutgers University. Surprisingly, these programs have collected only minimal data from their participants and few results have been published in refereed journals. Minimal results have been distributed at a WEPAN (Women in Engineering Program Advocates Network) conference and published in a conference summary book (Deno, 1993). The lack of program evaluations and longitudinal research designs of LLCs for women majoring in

science and engineering make it difficult for administrators of new LLCs to develop helpful programs. The increasing number of such interventions coupled with the lack of published research on these programs calls for a systematic analysis of such interventions.

Pilot Data Supporting the Present Study

Greenfield et al. (1982) averred that attracting students to engineering is important but stressed it is imperative that institutions provide students with appropriate counseling and support services during their enrollment. An LLC is one way of providing support services for women studying nontraditional majors, and Betz (1997) advocated the utility of residence hall floors for special groups as an intervention to attract and retain women and minorities in nontraditional majors. A living learning center was established at Iowa State University of Science and Technology for the first time during the 1995-1996 academic year. First-year women in nontraditional majors at the university were provided the option of sharing residence facilities with other first-year women in similar majors.

A program evaluation was completed using data collected during the intervention's first operational year (Gandhi, 1997). Consistent with research (e.g., Pascarella & Terenzini, 1981; Blimling, 1993; Schroeder & Griffin, 1976), the program evaluators proposed that the LLC participants would report higher grades, retention, academic and social confidence, and adjustment compared to women who had applied to the LLC but were refused due to lack of space and to a random sample of other first-year women studying nontraditional academic majors at the university.

Contrary to these hypotheses, the study's most prominent finding was the lack of difference between the LLC group and the two comparison groups. The chief exception to this pattern was academic performance, but the direction of the difference on this dimension was the opposite of that predicted. To better understand the results, post hoc analyses were performed to contrast the women on the LLC residence hall containing the highest

concentration of women in science and engineering with the comparison groups. The academic performance differences found in earlier analyses disappeared and two non-significant trends were noted. First, the women on the LLC residence hall with the highest concentration of women in science and engineering tended to feel less confident in their academic coursework abilities. Second, a higher percentage of women were retained in nontraditional majors in the highly concentrated LLC residence hall than in the comparison groups. These results suggested that low academic confidence and low concentration of women in the LLC might help explain why the study's hypotheses were not confirmed.

The program evaluators suggested several modifications for the intervention. First, based on the post hoc analyses, they suggested that the concentration of women on each residence hall floor within the LLC be increased and that the intervention provide more academic programming or opportunities for its members. Second, they proposed that the study be extended to assess the intervention's effects on its participants longitudinally. Several vocational researchers have been proponents for longitudinal research involving college students. In their review of the self-efficacy literature, Lent and Hackett (1987) suggested that longitudinal research designs provide an opportunity to assess the development and changes of career self-efficacy over time. Also, Matyas (1992) asserted that evaluations of interventions involving women studying science and engineering should include a longitudinal research design.

Data collection for the present study continued through the spring of 1998, at which time the initial participants had completed their third academic year at the university. During this time the concentration of LLC members on all but one of the residence hall floors was increased and academic tutoring was offered for LLC members. Following the implementation of the initial program evaluation's suggested modifications, it is now appropriate to reevaluate the utility of the intervention.

METHOD

Overview of the Study

This longitudinal study began in 1995 and was conducted over three consecutive academic years at Iowa State University. A program evaluation was completed using data collected during the first year of the intervention, and the evaluation produced recommendations for programmatic and data collection modifications (Gandhi, 1997). Several of these recommendations were implemented and changes occurred in the collection of data during the second and third years of the study. Because these changes did not affect the primary hypotheses of the study, it was determined that these changes did not significantly compromise longitudinal comparisons within the data set.

Participants

Cohort 1

Participants in this cohort were first-year female undergraduate students who entered Iowa State University in 1995 and declared academic majors in math, engineering, or the biological, physical, social, or computer sciences (see Appendix A for a complete listing). The participants fell into one of three groups: 45 (44.6%) students who applied to and were accepted into a Living Learning Center (LLC), 13 (12.9%) students who applied to the LLC but were denied for lack of space, and 43 (42.6%) students selected randomly who did not apply to participate in the LLC. All participants in the study were identified through a computerized sort of files from the Registrar's Office and files from the Program for Women in Science and Engineering.

Cohorts 2 and 3

Participants in Cohorts 2 and 3 entered Iowa State University in 1996 and 1997, respectively. They were first-year female undergraduate students studying the same majors as participants in Cohort 1. One group of each cohort was comprised of all students

who were accepted to the established LLC; the other group of each cohort consisted of a random sample of students who had not applied to the LLC. A computerized sort of files from the Registrar's Office and files from the Program for Women in Science and Engineering were used to identify appropriate participants for the study. The final sample for Cohort 2 included 61 (46.2%) students who were members of the LLC and 71 (53.8%) students who had not applied to the LLC. Cohort 3 was comprised of 43 (35.0%) LLC participants and 80 (65.0%) non-participants

Intervention

Cohort 1

The women accepted into the LLC were placed on one of four residence hall floors in two different dormitories on campus. Each floor held both members of the LLC and other female undergraduate students in programs of study other than science, math, and engineering. The separation of the LLC members was required logistically due to space limitations within the university residence hall system. As a result, the density of LLC members on each floor varied greatly; the percentages of LLC members on the four floors are presented in Table 1.

All women who applied to the LLC, whether accepted or not, received the same promotional information throughout the academic year about special seminars and opportunities such as computer workshops, picnics, member get-togethers, seasonal parties, test files, and seminars on topics of interest to this population, such as sexual harassment and test anxiety (see Appendix B). These events were planned specifically for these women and were in addition to the Program for Women in Science and Engineering's typical programming available to all university undergraduate women in these majors.

In summary, participants accepted into the LLC lived within the intervention and received invitations to programming designed specifically for the LLC members. The

participants who applied but were not accepted due to lack of space did not live within the intervention but did receive invitations to the specialized programming. In contrast, the participants who did not apply to live in the LLC did not reside within the intervention and did not receive invitations to the specialized programming.

Cohorts 2 and 3

The intervention was expanded during the second and third years of the program due to its popularity. Members of the LLC resided on seven residence hall floors in three campus dormitories and the LLC was able to accommodate all students who applied to the program. Members of the LLC requested that the residence hall floors remain heterogeneous, and the floors continued to house both members of the LLC and students studying curricula other than science, math, or engineering. However, based on recommendations of the first year program evaluation (Gandhi, 1997), the concentration of LLC members on the floors was increased (with one exception) in an attempt to intensify positive effects of the intervention on its members (see Table 3.1). To compare the concentration of women in science, math, and engineering majors in the LLC with other residence halls, ten female residence hall floors during the 1996-1997 academic year were randomly chosen and the percentages of women in these academic majors on each residence hall were calculated. The percentages of women studying science, math, or engineering on these floors ranged from 16.7% to 59.1% (Median = 24.7%).

Programming similar to that offered during the first year of the intervention continued during the second and third years. In an effort to foster greater academic achievement, free tutoring was provided at the end of the second year and throughout the third year for all LLC members desiring assistance in mathematics, chemistry, and physics courses.

Table 3.1

Concentration Percentages of LLC Members on Residence Hall Floors by Year

	1995-1996	1996-1997	1997-1998
Henderson	4.9%	N/A	N/A
Hutton	23.4%	28.6%	14.3%
Knowles	28.0%	24.6%	36.1%
Lawther	46.8%	40.7%	66.7%
Rowe	N/A	42.3%	69.2%
Sadler	N/A	55.6%	73.3%
Shilling	N/A	15.9%	30.2%
Tilden	N/A	39.6%	45.3%
Median of all floors	25.7%	39.6%	45.3%

Procedure

Cohort 1

Prior to the fall semester, a computerized sort generated the names of women entering Iowa State University as first-year students who had declared a major in engineering, mathematics, or the biological, physical, social, or computer sciences. Women on this list were contacted by the Iowa State University Program for Women in Science and Engineering in the summer prior to admittance and invited to participate in a new program aimed at retaining women in these academic fields. It was explained that the program would be a shared living experience with other first-year university women in the identified majors. The women were informed that, due to limited space, the first respondents would be accorded this unique opportunity (see Appendix C).

Applicants accepted into the LLC, the treatment group, were determined by self-selection (i.e., quickness of response). The women who had been accepted into the program were contacted by telephone approximately six weeks after their entrance into the university to complete a written background questionnaire. During the following two weeks, the questionnaires were administered in groups of one to six individuals, after which each

participant scheduled an individual interview six weeks later that focused on her adjustment to her new environment. Informed consent and academic record release forms were presented at the time of questionnaire administration (see Appendix D).

Women who had applied to the LLC but were denied entrance were contacted and assessed using the same procedures and measures as the treatment group. They comprised a comparison group to control for interest and motivation.

Approximately eight months after their entrance to the university, the women were mailed a follow-up questionnaire to complete and return that focused on retention, self-efficacy in both academic and social settings, perceived encouragement from others, comparison of personal traits with others in similar majors, and reasons for their career choice (see Appendix E). Reminder postcards and second copies of the questionnaire were sent to participants who had not returned their questionnaires by the requested date (see Appendix F).

From the original university roster of first-year women in engineering, math, and science programs of study, a list of the women who had not applied to the LLC was compiled, and each woman was assigned a computer generated random number. Beginning with the woman assigned the lowest random number, women in this nonparticipant group were contacted by telephone in order of their random numbers approximately nine weeks after their entrance to the university. The first 60 women willing to participate in the study were included in the nonparticipant control group. They were mailed the same informed consent form, academic record release form, and written background questionnaire administered to the accepted and denied participant samples (see Appendix G). Reminder postcards were sent to participants who had not responded by a certain date (see Appendix H). The women in this nonparticipant sample were also mailed the same follow-up questionnaire administered to the applicants (with the omission

of one scale querying applicants' reasons for participating in the LLC) approximately eight months after their entrance to the university. Reminder postcards and second copies of the questionnaires were sent to those respondents that did not respond by a specified date (see Appendix F).

Members of the LLC were mailed follow-up questionnaires in the spring semester of each subsequent academic year. These questionnaires were similar to the follow-up questionnaires the students completed during their first year at the university. Additionally, academic grades and retention information were collected for each year the members participated in the study.

Cohorts 2 and 3

Data was collected from cohorts 2 and 3 using similar background and follow-up questionnaires. Telephone solicitation and individual interviews were eliminated for these cohorts and the participants received all questionnaires by mail. All applicants to the LLC in groups 2 and 3 were accepted, thus eliminating a comparison group to control for interest and motivation. Other aspects of research design and data collection methods remained similar to those used with cohort 1.

Measures

Instruments used in this study to assess background and outcome variables generally have been shown to be psychometrically acceptable measures; minimal information is available for instruments assessing the LLC. All of the measures have high face validity.

Background Variables

Demographics

Demographic information on age, race, university major, and current living environment was gathered on the initial background questionnaire. Further questions were

asked about family of origin, educational aspirations and background, high school science and math courses, and current curricula (see Appendix I).

Academic Aptitude

American College Testing (ACT) exam scores were used as a measure of aptitude. Participants were asked to report their ACT scores on the background questionnaire and records from the Registrar's Office were used to verify this information. ACT scores for six 2000 person samples studied during 1989 through 1990 yielded summary KR20 coefficients of .91 (ACT-English), .89 (ACT-Math), .81 (ACT-Reading), .78 (ACT-Science Reasoning), and .95 (ACT-Composite) (American College Testing Program, 1991).

Role Models

Information about role models was assessed using three separate self-report measures. The first measure asked how many women the respondent knew in each of four occupations: science teachers, math teachers, scientists, and engineers. Secondly, the student was asked to list the number of female math and science instructors she had during grades six through 12. These measures indicate the amount of exposure to women in several nontraditional careers (see Appendix J).

A third measure assessed the level of encouragement, both in general and in relation to nontraditional career choice, each woman perceived from those in her environment (See Appendix K). The Role Models Influence Scale (RMIS; Basow & Howe, 1980) asked the respondent to rate 12 individuals with whom she has had contact (e.g., mother, father, siblings, and male and female teachers, relatives, and acquaintances employed in math and science occupations) on their perceived encouragement in general and in relation to choosing a major in science, math, and engineering using a Likert-type 7-point scale (-3=negative influence, +3=positive influence). This scale can be scored in numerous ways but typically is analyzed at the item level. The RMIS has been used to

assess the perceived influence on nontraditional career choice. Although issues of reliability haven't been addressed effectively using analysis at the item level, Hackett et al. (1989) did report that the instrument predicted several variables, including career salience, educational aspirations, and nontraditional occupation choice.

Self-Efficacy in Nontraditional Coursework

The math-related courses subscale of the Mathematics Self-Efficacy Scale (MSE; Betz & Hackett, 1983) was used to assess self-efficacy for nontraditional academic coursework. This 16-item subscale of the instrument asked participants to assess their confidence in completing each of 16 math-related college courses with a "B" grade or better on a Likert-type 10-point scale (1=no confidence at all, 10=complete confidence) (see Appendix L). Wording on the course title "basic college math" to "college algebra" was modified to assist in clarity.

Internal consistency reliability for the math-related subscale of the MSE has been reported at .93 (Betz & Hackett, 1983). Reliability estimates were reported at .89 and .90 on two administrations of this instrument with students in cohort 1 of the current study (Gandhi, 1997). The scale developers have further found that math self-efficacy, as measured by the MSE, is predictive of math anxiety and math-related career choice (Hackett & Betz, 1989; Hackett, 1985).

Science-related self-efficacy (SSE) was measured in the present study by asking students to assess their confidence in completing seven scientific courses (see Appendix L). Participants used the MSE instructions and rating scale for these self-evaluations. Internal consistency measured by coefficient alpha has been reported using data collected from high school women aspiring to science and engineering careers and with data collected from cohort 1 (Gandhi, 1997). Pilot data on this scale from female high school students (N=69) produced an internal consistency of .85. Reliability estimates were reported at .85

and .86 in two administrations of the instrument with students in group 1 of the current study (Gandhi, 1997).

Outcome Variables

A variety of outcome measures were used in the present study. Behavioral data of academic performance and retention was collected from university records. Modified clusters of items from scales originally developed by the University of Michigan-Women in Science and Engineering Program (UM-WISE) specifically for women in LLCs were also included in the follow-up questionnaire. Other measures administered in the background questionnaire were repeated in the follow-up questionnaire to assess differences over time. The psychometric properties will be calculated and reported for all of the proposed scales.

Academic Performance

Academic achievement was measured using self-report data verified with records from the Registrar's Office. Semester and cumulative grade-point averages for each participant were computed.

Retention

Retention at the university and in the original program of study after each academic year were determined through records from the Registrar's Office and the Program for Women in Science and Engineering. Educational goals were assessed on the follow-up questionnaire as an aspect of academic commitment (see Appendix M).

Confidence of Academic Achievement

This 20-item scale provided a global assessment of participants' confidence in a range of academic and interpersonal activities. Participants were asked to assess their comfort interacting with others in their fields, their abilities to complete their coursework and degrees, and their abilities to integrate their personal and academic lives using a Likert-type 10-point scale (1=no confidence at all, 10=complete confidence) (see Appendix N). This

scale produced a reliability estimate of .93 with students in cohort 1 of the current study (Gandhi, 1997). Efforts to reduce the length of the survey and to narrow the focus of the topics assessed with this instrument prompted the elimination of fourteen items from the original scale for administrations with cohorts 2 and 3. The revised scale queried participants' confidence in completing their degrees and in utilizing knowledge gained through academic coursework.

Confidence of Receiving Support within Science and Engineering Fields

Participants were asked to indicate their confidence in receiving general encouragement and acceptance by others in science, math, and engineering using a using a Likert-type 10-point scale (1=no confidence at all, 10=complete confidence) (see Appendix O). The reliability estimate for this seven-item scale was reported at .88 with the members of cohort 1 in the current study (Gandhi, 1997). Two items assessing participants' expectations of receiving greater support within their fields were added to the scale for administration with cohorts 2 and 3.

Self Confidence in Academic Skills

This scale queried participants' own rankings of a range of skills related to academic success in comparison to other students in science, math, and engineering (see Appendix P). Ratings of "lowest 10%," "below average," "average," "above average," and "highest 10%" were used for items such as knowledge of field or discipline, competitiveness, and scientific reasoning. The reliability estimate for this 19-item scale was reported at .91 with cohort 1 of the current study (Gandhi, 1997). Due to concerns of survey length and in an effort to narrow the focus of the instrument, ten items were eliminated from the scale for administration with cohorts 2 and 3. The revised nine-item scale concentrated on interpersonal and work styles and academic skills specific to the fields of science, math, and engineering.

Personal Adjustment

An adjustment scale was formed from items drawn from a UM-WISE instrument. The reliability estimate for this scale was reported at .46 in an administration with cohort 1 (Gandhi, 1997). Revisions aimed at increasing internal consistencies resulted in the inclusion of six additional items assessing emotional and physical well-being, overall adjustment, and general affect (see Appendix Q). The revised scale was used in administrations with cohorts 2 and 3.

Self-Efficacy in Nontraditional Coursework

Math and science-related self-efficacy were assessed again with the MSE and SSE used in the background questionnaire. Changes in respondents' feelings of self-efficacy since the background questionnaire administration will be assessed in these repeated outcome measures.

Role Models

Changes in respondents' feelings of role model support will be assessed with a repeated administration of the RMIS. Comparisons between participants' ratings on the background and follow-up questionnaires will be analyzed and reported.

Qualitative questions

Four qualitative questions were posed in the follow-up questionnaire for information gathering purposes. These items are listed below.

1. Why did you select Iowa State University?
2. Why did you select a major in science, math, or engineering?
3. When did you first become interested in science/math/engineering?
4. Who or what provided you with information about programs or careers in science or engineering?

Process Variables

An additional questionnaire was included in the surveys administered to all of the women who had applied to the living learning center (see Appendix R). Participants were asked to indicate the degree of influence several factors had on the choice to apply for the LLC using a Likert-type 10-point scale (1=did not influence my decision at all, 10=greatly influenced my decision). Sample items included wanting to be part of a smaller group on campus, receiving informal help or tutoring, and encouragement from advisors.

RESULTS

Psychometric Properties of Scales

The reliabilities for the multi-item scales, including the Math Self-Efficacy Scale (MSE), Science Self-Efficacy Scale (SSE), Confidence in Academic Achievement Scale, Confidence of Within Field Support Scale, Self-Confidence in Academic Skills Scale, and Personal Adjustment Scale were examined, using coefficient alpha. Several estimates of reliability were calculated for the Role Model Influences Scale due to its somewhat heterogeneous content. Coefficient alpha was calculated for overall role model support, role model support from females, and role model support from immediate family members. As indicated in Table 4.1, all measures yielded reliability estimates of at least .80.

Table 4.1

Reliability Estimates of Background and Follow-up Questionnaires

Scale	Coefficient Alpha	Questionnaire Administration
MSE	.91	Background
SSE	.83	Background
Role Model Influences Scale (total support)	.88	Background
Role Model Influences Scale (female support)	.80	Background
Role Model Influences Scales (family support)	.81	Background
Confidence in Academic Achievement	.89	Follow-up
Confidence of Within Field Support	.86	Follow-up
Self-Confidence in Academic Skills	.82	Follow-up
Personal Adjustment	.82	Follow-up

Background Analyses

Study participants were not assigned randomly to reside in the LLC or traditional residence halls. Due to concerns of participant self-selection as a confounding variable in the outcome analyses, background variables were analyzed to test for pre-enrollment differences between those who applied to the LLC program and those who did not. The background analyses examined the applicant groups across the three cohorts and also studied each cohort separately. Data were analyzed from students who had completed all of the background and follow-up questionnaires. Overall, less than 2% of the data were missing on the questionnaires. Missing data within scales were substituted with the scale mean for each individual, and single-item scales with missing data were left unchanged. Chi-square analyses were used to test for differences on categorical variables and t-tests were used to test for differences on continuous variables.

The background analyses were conducted to verify the absence of pre-existing differences between the groups, particularly within the aptitude measures. A two-fold procedure was employed to determine potential covariates to be used in the outcome analyses. First, a relaxed alpha of .20 was used to identify variables that achieved significance at this level. Second, confidence intervals were constructed to interpret the clinical meaning of the variables identified in the first stage of the procedure. A Bonferroni adjustment was used to increase the width of the confidence intervals, thus exhibiting the "worst case scenario" of differences between the groups.

Aptitude Variables

ACT scores were analyzed as a measure of aptitude. Complete score information was available for 141 applicants and 194 non-applicants. Even with a relaxed alpha level of .20, T-tests failed to reveal differences between the groups on any of the four dimensions of

the ACT (math, English, reading, or science reasoning) or on the composite score, as indicated in Table 4.2.

The ACT scores of applicants and non-applicants were substantially higher than national mean scores and the mean scores of students entering Iowa State University in 1995, the year the LLC began. Additionally, the profiles for both groups were quite flat, indicating high ability across the dimensions measured by the ACT. As indicated in Table 4.2, students in this study scored between one and two standard deviation units above the national mean (American College Testing Program, 1991) and about .67 standard deviation units above the university mean (Iowa State University Office of Institutional Research, 1997).

The participant groups were also assessed for differences in high school rank as a measure of pre-college aptitude. The mean scores of the two groups were not significantly different ($t(330) = 0.754$, $p = .45$). On average, study participants achieved a high school rank of 85.6 ($SD = 12.65$). To further ensure there were no differences in aptitude variables, additional analyses were performed to assess differences within each cohort. These analyses found no significant differences between the applicant groups.

Demographic Variables

As indicated in Table 4.3, chi-square tests failed to reveal differences between applicants and non-applicants in regard to race, state of origin, type of high school, highest educational aspiration, father's employment, father's education, and female family members' education other than mother. Parents' marital status, mother's education, mother's employment, and size of hometown were significant at $p < .20$. However, the calculated confidence intervals did not suggest a meaningful difference between the groups' mean scores on these variables, and no systemic pattern of group differences emerged. Whereas the groups differed somewhat in mother's education level, none of the other

Table 4.2

Means, Standard Deviations, and t Values for Comparisons of Applicant Groups and Fall 1995 ISU Entrants on ACT scores

ACT Subtest	Applicants (n=141)	Non-applicants (n=194)	t	p-value	99% Confidence Intervals	Scores for 2900 Fall 1995 ISU Entrants	Scores for ACT users in 1991
Composite			0.314	.753	-3.08 / 2.11		
Mean	26.23	26.11				24.4	20.6
SD	3.37	3.59				3.8	4.5
English			-0.365	.715	-3.51 / 2.87		
Mean	25.35	25.53				23.6	20.3
SD	4.15	4.36				4.3	5.2
Math			0.032	.975	-3.34 / 1.61		
Mean	25.60	25.58				24.2	19.9
SD	3.63	4.04				4.2	4.7
Reading			0.439	.661	-4.00 / 3.50		
Mean	27.07	26.83				24.7	21.2
SD	4.96	4.96				5.2	6.1
Science			0.467	.641	-3.34 / 2.41		
Mean	26.13	25.94				24.5	20.6
SD	3.76	3.63				4.1	4.5

Table 4.3

Frequencies, Percentages, and Chi-Square Values for Comparison of Applicant Groups on Categorical Demographic Variables

Background variable	Applicant N	Applicant Percentage	Non-applicant N	Non-applicant Percentage	Total Sample Percentages	Chi Square	p-value	99.91% Confidence Interval
Race						0.471	.493	-0.11 / 0.07
Caucasian	139	93.3	189	91.3	92.1			
Noncaucasian	10	6.7	18	8.7	7.9			
Anticipated Degree						1.512	.219	-0.22 / 0.10
BS	56	37.8	65	31.6	34.2			
MS/PhD	92	62.2	141	68.4	65.8			
Mother' Education						2.652	.103	-0.08 / 0.25
High school or less	67	45.6	112	54.4	50.7			
Post-secondary degree	80	54.4	94	45.6	49.3			
Father's Education						0.112	.738	-0.19 / 0.15
High school or less	76	52.1	103	50.2	51.0			
Post-secondary degree	70	47.9	102	49.8	49.0			
Aunt's Education						1.168	.280	-0.11 / 0.23
High school or less	61	43.6	100	49.5	47.1			
Post-secondary degree	79	56.4	102	50.5	52.9			
Maternal Grandmother's Education						0.020	.887	-0.13 / 0.12
High school or less	117	84.2	163	83.6	83.8			
Post-secondary degree	22	15.8	32	16.4	16.2			
Paternal Grandmother's Education						0.080	.777	-0.11 / 0.13
High school or less	119	86.2	165	87.3	86.9			
Post-secondary degree	19	13.8	24	12.7	13.1			

Table 4.3 continued

Background variable	Applicant N	Applicant Percentage	Non-applicant N	Non-applicant Percentage	Total Sample Percentages	Chi Square	p-value	99.91% Confidence Interval
Mother's Employment						3.415	.065	-0.04 / 0.17
Never employed	20	13.8	16	7.7	10.2			
Employed	125	86.2	191	92.3	89.8			
Father's Employment						--	--	--
Never employed	0	0.0	1	0.5	0.3			
Employed	143	100	200	99.5	99.7			
Parents' Marital Status						2.151	.143	-0.20 / 0.07
Married	122	81.9	156	75.4	78.1			
Not married	27	18.1	51	24.6	21.9			
High school Type						0.238	.626	-0.08 / 0.12
Public	133	89.3	188	90.8	90.2			
Private	16	10.7	19	9.2	9.8			
Hometown						7.980	.005	-0.01 / 0.30
In town or suburb	89	61.4	154	75.5	69.6			
In country or on farm	56	38.6	50	24.5	30.4			
Home State						0.035	.851	-0.15 / 0.17
Iowa	93	62.8	127	63.8	63.4			
Outside of Iowa	55	37.2	72	36.2	36.6			

Chi-square statistics were not computed for father's employment status due to the low number of fathers unemployed.

female family members' education levels were different between the groups. Variables assessing mother's employment, parents' marital status, and size of hometown were somewhat different between the two applicant groups but the groups' percentages were always in the same direction.

T-tests failed to reveal group differences on the continuous background variables of quality of high school preparation for college, high school class size, and number of acquaintances at the university, as indicated in Table 4.4. Number of siblings and acquaintances within science, math, and engineering were significant at $p < .20$ but the confidence intervals did not seem to indicate meaningful group differences on these variables. The difference in number of siblings was less than one, and the difference in acquaintances was less than five, according to the "worst case scenario" confidence intervals. Additional analyses were performed to assess differences within each cohort to verify there were no differences in demographic variables. These analyses found no significant differences between the applicant groups.

Role Models

Information about role models was assessed using three self-report measures. The first measure asked for the number of female science teachers, math teachers, scientists, and engineers known to respondents. The two applicant groups did not differ significantly on this measure ($t(255) = 0.196$, $p = .85$). On average, study participants knew 6.87 female science and math teachers, scientists, and engineers ($SD = 7.43$). A second measure asked for the number of female math and science instructors study participants had during grades six through 12. The mean responses of the two groups were not significantly different ($t(346) = -0.702$, $p = .48$). On average, study participants had 5.65 female math and science instructors during grades six through 12 ($SD = 4.26$).

Table 4.4

Means, Standard Deviations, and t Values for Comparison of Applicant Groups on Continuous Demographic Variables

Background variable	LLC Applicants	LLC Non-applicants	t	p-value	99.91% Confidence Interval
Number of Siblings			-1.886	.060	-0.73 / 0.21
N	149	207			
Mean	1.73	2.00			
SD	1.36	1.22			
HS Preparation Assessment			0.166	.868	-0.31 / 0.34
N	149	206			
Mean	3.81	3.80			
SD	0.82	0.99			
HS Class Size			-0.903	.367	-75.92 / 43.68
N	149	206			
Mean	209.30	225.41			
SD	161.60	171.81			
ISU Acquaintances			0.126	.900	-3.64 / 3.92
N	149	206			
Mean	7.95	7.81			
SD	11.25	9.28			
Sci, Math, Eng Acquaintances			1.564	.119	-1.30 / 3.55
N	147	201			
Mean	5.01	3.88			
SD	7.79	4.62			

A third measure, the Role Models Influence Scale, assessed the level of encouragement by those in the respondents' environments in general and in relation to choosing a science, math, or engineering major. To measure overall support, the total scores for both versions of the scale were compared between the two applicant groups. The groups did not differ significantly in general support ($t(320) = -1.00$, $p = .318$) or in

support for pursuing a science, math, or engineering major ($t(314) = .133$, $p = .894$). Both groups reported an overall positive influence from individuals in their lives, as reflected by an overall mean of 66.59 ($SD = 9.07$) out of a possible score of 84.00 for general support and an overall mean of 96.60 ($SD = 13.97$) out of a possible score of 126.00 for support in pursuing a science, math, or engineering major. A series of t-tests on each item within each of the two versions of the RMIS further analyzed differences between the two applicant groups. These analyses revealed no significant differences among the 40 t-tests performed. Additional analyses assessing differences between the applicant groups within each cohort found no differences in background levels of role model support.

Self-Efficacy

The Math Self-Efficacy Scale (MSE) and the related Science Self-Efficacy Scale (SSE) on the background questionnaire were analyzed to look for differences between the two applicant groups. T-tests indicated that the groups did not differ in their confidence for completing math ($t(317) = 0.921$, $p = .358$) or science-related ($t(313) = 1.114$, $p = .266$) college courses with a "B" grade or better, and on average, the groups exhibited relatively high confidence in their abilities (Math $M = 7.50$, $SD = 1.38$; Science $M = 6.94$, $SD = 1.57$ on a 10-point scale). Additionally, no differences were found in analyses assessing differences between the applicant groups within each cohort.

Outcome Analyses

Because no differences emerged between applicant groups in background analyses across cohorts or within each cohort, it was not necessary to use covariates in the outcome analyses. The assessment of outcome variables consisted of five sets of analyses. Variables assessed and methods of analysis utilized are listed in Table 4.5. In the first set of analyses, independent sample t-tests and chi-square analyses were used to test for

Table 4.5

Variables and Assessment Methods of Outcome Analyses

Contrast	Dependent Variable	Method of Analysis
Set 1		
Treatment group vs. control group	First-year Campus and Personal Adjustment	Independent Sample t-tests; Chi-square
Treatment group vs. control group	First-year Academic Confidence and Expectations	Independent Sample t-tests
Treatment group vs. control group	First-year Support and Encouragement	Independent Sample t-tests
Set 2		
Treatment group vs. control group	Academic Performance and Retention	Independent Sample t-tests; Chi-square
Set 3		
All respondents at initial follow-up vs. All respondents at recent follow-up	Academic Performance	Paired Sample t-tests; Chi-square
Set 4		
Treatment group at initial follow-up vs. Treatment group at recent follow-up	Campus and Personal Adjustment	Paired Sample t-tests
Treatment group at initial follow-up vs. Treatment group at recent follow-up	Academic Confidence and Expectations	Paired Sample t-tests
Treatment group at initial follow-up vs. Treatment group at recent follow-up	Support and Encouragement	Paired Sample t-tests
Set 5		
All respondents	Retention Prediction	Logistic Regression

differences between all LLC participants and all non-participants at the conclusion of their first year at the university. Comparisons were made on the continuous variables of the Confidence of Academic Achievement Scale, Confidence of Within Field Support Scale, Self- Confidence in Academic Skills Scale, Personal Adjustment Scale, Math Self-Efficacy

Scale, Science Self-Efficacy Scale, and selected items from the Role Model Influence Scale. Separate analyses were used to assess differences between participants and non-participants on twelve single-item campus involvement questions in addition to the multi-item Personal Adjustment Scale. Seven t-tests were conducted on individual item continuous variables and five chi-square tests assessed individual item categorical variables. A Bonferroni adjustment was used in the outcome analyses to avoid spurious results due to a Type I error. Adjusted p-values and confidence intervals for the differences between groups are listed with each table, and effect sizes were computed for all continuous variables that achieved a p-value < .10.

The second set of analyses tested for differences between participants and non-participants on the variables of academic grade point average, university retention, and retention in a nontraditional academic major. Independent sample t-tests and chi-square analyses were used to assess group differences. The third set of analyses utilized paired sample t-tests and chi-square analyses to assess changes over time in academic performance and grade expectations among all respondents. Comparisons were made across cohorts and within each cohort in both sets of analyses, and a Bonferroni adjustment was used to avoid Type I errors. Effect sizes were computed for continuous variables that reached a significance level <.10.

Paired comparisons, again using a Bonferroni adjustment, were used in the fourth analysis to test for differences between LLC participants' responses on the initial follow-up questionnaire administered in the spring semester of their first year and responses on the most recent follow-up questionnaire. These analyses were conducted to assess changes over time within LLC participants. According to Moore and McCabe (1989), paired comparisons are frequently utilized in projects similar to the proposed study where randomization is not possible, and Keppel and Zedeck (1989) have asserted that a paired

comparisons analysis is preferred over an omnibus *F* test in this research design because a priori comparisons have been determined based on previous research findings. These comparisons were made on the multi-item scale variables used in the first set of analyses.

The fifth set of analyses utilized logistic regression to assess which variables are most useful at predicting retention in nontraditional majors and at the university. Predictor variables used in these analyses and the results are presented.

Adjustment, Self-Efficacy, and Support Differences in LLC Participants and Non-participants

Campus and Personal Adjustment

The current study predicted that the participants in the LLC would report better adjustment in the university setting than the women who did not participate in the LLC. The dimensions of personal and campus adjustment within the university setting were measured using several multi-item and single-item scales. Because adjustment data from LLC non-participants were collected only in their first year at the university, data from each cohort's first follow-up questionnaire were used in these analyses. As indicated earlier, the personal adjustment scale was dramatically changed in the second year of data collection. For this reason, data from cohort 1 for this scale were excluded from the analyses.

No significant differences were found between the groups on the multi-item adjustment scale, but several single-item scales suggested that LLC participants enjoyed higher levels of adjustment than non-participants. Overall, the respondents indicated high levels of adjustment on each scale and results of these analyses are presented in Tables 4.6 and 4.7. Across all cohorts, LLC members reported significantly less difficulty getting to know their residence hall floormates, LLC members felt more strongly than non-participants that they shared commonalities with their residence hall floormates, a significantly greater number of LLC members affirmed that they would choose to live on the same residence hall floor again, and significantly more members of the LLC reported that they intend to join or

Table 4.6

Means, Standard Deviations, and t Values for Comparison of Participant Groups on Adjustment Scales

Scale	N	Mean	SD	t	p-value	Effect Size	99.94% Confidence Interval
Personal Adjustment (multi-item scale)							
All cohorts				1.220	.230	--	-0.13 / 0.36
Participants	80	3.93	0.63				
Non-participants	124	3.82	0.68				
Cohort 1				--	--	--	--
Participants	--	--	--				
Non-participants	--	--	--				
Cohort 2				0.473	.637	--	-0.28 / .40
Participants	47	3.91	0.61				
Non-participants	56	3.85	0.69				
Cohort 3				1.196	.236	--	-0.21 / 0.55
Participants	33	3.96	0.67				
Non-participants	68	3.79	0.67				
Difficulty getting to know others on residence floor (single-item scale)							
All cohorts				-3.607	.000	.42	1.75 / 0.29
Participants	120	3.26	2.11				
Non-participants	159	4.28	2.60				
Cohort 1				-1.349	.181	--	-1.92 / 0.62
Participants	40	3.18	1.81				
Non-participants	46	3.83	2.64				
Cohort 2				-2.629	.010	.51	-2.56 / .001
Participants	47	3.34	2.07				
Non-participants	50	4.62	2.70				
Cohort 3				-2.019	.048	.43	-2.53 / 0.34
Participants	33	3.24	2.53				
Non-participants	63	4.33	2.50				

Table 4.6 continued

Scale	N	Mean	SD	t	p-value	Effect Size	99.94% Confidence Interval
Amount in common with floormates (single-item scale)							
All cohorts				3.020	.003	.36	0.13 / 1.72
Participants	120	6.33	2.57				
Non-participants	160	5.40	2.49				
Cohort 1				-1.349	.181	--	-1.92 / 0.62
Participants	40	6.38	2.46				
Non-participants	47	5.70	2.79				
Cohort 2				1.367	.175	--	-0.64 / 2.01
Participants	47	6.15	2.48				
Non-participants	50	5.46	2.48				
Cohort 3				2.410	.019	.54	-0.15 / 2.93
Participants	33	6.52	2.87				
Non-participants	63	5.13	2.27				

Multi-item adjustment scale information not available for Cohort 1.
Note: Alpha, using a Bonferroni correction, equals 0.006.

have already joined the campus organizations of the Society for Women Engineers (SWE) and the Association for Women in Science (AWIS). Significant differences between participant groups were noted within cohorts as well. Within Cohort 2, more LLC participants reported they would like to live on the same residence hall again, have joined or would join SWE, and have joined or would join AWIS. Nonsignificant trends suggested that within Cohort 2, fewer LLC participants than non-participants agreed that they have joined or would join a sorority on campus and the Honors program. In addition, a nonsignificant trend indicated that LLC participants within Cohort 3 were more likely to have joined or intend to join AWIS than nonparticipants within the same cohort.

Academic Confidence, Self-Efficacy, and Expectations

It was predicted that the participants in the LLC would report greater academic confidence and self-efficacy than the women who did not participate in the LLC. Several multi-item and single-item scales were utilized to assess for differences between the two

Table 4.7

Frequencies and Chi-Square Values for Comparison of Participant Groups on Adjustment Scales

Variable	Yes	Percent	No	Percent	Chi Square	p-value	99.94% Confidence Interval
Would live on the same residence hall floor again							
All cohorts					18.607	.000	0.08 / 0.38
Participants	105	87.5	15	12.5			
Non-participants	103	64.8	56	35.2			
Cohort 1					1.260	.262	-0.17 / 0.38
Participants	33	82.5	7	17.5			
Non-participants	34	72.3	13	27.7			
Cohort 2					19.081	.000	0.14 / 0.61
Participants	45	95.7	2	4.3			
Non-participants	29	58.0	21	42.0			
Cohort 3					3.102	.078	-0.11 / 0.45
Participants	27	81.8	6	18.2			
Non-participants	40	64.5	22	35.5			
Intend to join or have joined SWE							
All cohorts					12.769	.000	0.03 / 0.46
Participants	41	51.3	39	48.8			
Non-participants	33	26.6	91	73.4			
Cohort 1					--	--	--
Participants	--	--	--	--			
Non-participants	--	--	--	--			
Cohort 2					18.063	.000	0.12 / 0.65
Participants	24	51.1	23	48.9			
Non-participants	7	12.5	49	87.5			
Cohort 3					1.603	.206	-0.19 / 0.46
Participants	17	51.5	16	48.5			
Non-participants	26	38.2	42	61.8			
Intend to join or have joined AWIS							
All cohorts					13.945	.000	0.03 / 0.40
Participants	27	33.8	53	66.3			
Non-participants	15	12.1	109	87.9			
Cohort 1					--	--	--
Participants	--	--	--	--			
Non-participants	--	--	--	--			
Cohort 2					9.547	.002	0.00 / 0.51
Participants	17	36.2	30	63.8			
Non-participants	6	10.7	50	89.3			
Cohort 3					4.238	.040	-0.11 / 0.45
Participants	10	30.3	23	69.7			
Non-participants	9	13.2	59	86.8			

Table 4.7 continued

Variable	Yes	Percent	No	Percent	Chi Square	p-value	99.94% Confidence Interval
Intend to join or have joined a sorority							
All cohorts					2.757	.097	-0.24 / 0.06
Participants	8	10.0	72	90.0			
Non-participants	23	18.5	101	81.5			
Cohort 1					--	--	--
Participants	--	--	--	--			
Non-participants	--	--	--	--			
Cohort 2					3.825	.050	-0.33 / 0.07
Participants	3	6.4	44	93.6			
Non-participants	11	19.6	45	80.4			
Cohort 3					0.099	.753	-0.27 / 0.22
Participants	5	15.2	28	84.8			
Non-participants	12	17.6	56	82.4			
Intend to join or have joined the Honors Program							
All cohorts					2.201	.138	-0.26 / 0.09
Participants	13	16.3	67	83.7			
Non-participants	31	25.0	93	75.0			
Cohort 1					--	--	--
Participants	--	--	--	--			
Non-participants	--	--	--	--			
Cohort 2					3.800	.051	-0.40 / 0.08
Participants	6	12.8	41	87.2			
Non-participants	16	28.6	40	71.4			
Cohort 3					0.009	.923	-0.28 / 0.26
Participants	7	21.2	26	78.8			
Non-participants	15	22.1	53	77.9			

Program involvement data not available for Cohort 1.
Note: Alpha, using a Bonferroni correction, equals 0.006.

groups on these variables. As indicated in Table 4.8, only one significant difference was found between the groups. Within Cohort 2, LLC participants indicated greater certainty than non-participants of maintaining a nontraditional major, and a nonsignificant trend suggested this same difference across all of the cohorts. In general, the respondents indicated relatively high levels of academic confidence and self-efficacy overall.

Table 4.8

Means, Standard Deviations, and t Values for Comparison of Participant Groups on Academic Confidence, Self-Efficacy, and Expectations Scales

Scale	N	Mean	SD	t	p-value	Effect Size	99.2% Confidence Interval
Self-confidence in Academic Skills (multi-item scale)							
All cohorts				1.058	.291	--	-0.10 / 0.23
Participants	120	3.65	0.51				
Non-participants	173	3.58	0.56				
Cohort 1				-0.140	.889	--	-0.34 / 0.30
Participants	40	3.72	0.55				
Non-participants	49	3.74	0.60				
Cohort 2				0.958	.340	--	-0.17 / 0.37
Participants	47	3.61	0.51				
Non-participants	56	3.51	0.53				
Cohort 3				0.825	.412	--	-0.19 / 0.36
Participants	33	3.61	0.47				
Non-participants	68	3.52	0.54				
Confidence of Academic Achievement (multi-item scale)							
All cohorts				0.661	.509	--	-0.34 / 0.57
Participants	120	8.16	1.56				
Non-participants	172	8.04	1.34				
Cohort 1				-0.691	.492	--	-0.97 / 0.57
Participants	40	8.04	1.49				
Non-participants	49	8.24	1.19				
Cohort 2				0.536	.593	--	-0.59 / 0.89
Participants	47	8.31	1.50				
Non-participants	55	8.16	1.31				
Cohort 3				0.774	.442	--	-0.66 / 1.20
Participants	33	8.08	1.73				
Non-participants	68	7.81	1.44				
MSE (multi-item scale)							
All cohorts				0.717	.474	--	-0.31 / 0.54
Participants	116	7.53	1.33				
Non-participants	165	7.42	1.38				
Cohort 1				-0.378	.707	--	-0.84 / 0.63
Participants	39	7.60	1.41				
Non-participants	47	7.70	1.13				
Cohort 2				1.831	.070	.36	-0.23 / 1.30
Participants	46	7.65	1.32				
Non-participants	52	7.12	1.57				
Cohort 3				-0.618	.539	--	-0.91 / 0.57
Participants	31	7.27	1.24				
Non-participants	66	7.45	1.35				

Table 4.8 continued

Scale	N	Mean	SD	t	p-value	Effect Size	99.2% Confidence Interval
SSE (multi-item scale)							
All cohorts				0.347	.729	--	-0.44 / 0.57
Participants	115	6.55	1.62				
Non-participants	172	6.48	1.63				
Cohort 1				-0.023	.982	--	-0.98 / 0.96
Participants	39	6.49	1.73				
Non-participants	49	6.50	1.68				
Cohort 2				0.237	.813	--	-0.75 / 0.89
Participants	45	6.65	1.50				
Non-participants	55	6.58	1.62				
Cohort 3				0.242	.810	--	-0.87 / 1.04
Participants	31	6.48	1.67				
Non-participants	68	6.40	1.63				
Certainty of maintaining major (single-item scale)							
All cohorts				2.516	.013	.40	-0.04 / 2.11
Participants	63	8.19	2.18				
Non-participants	84	7.15	2.81				
Cohort 1				0.245	.807	--	-1.46 / 1.75
Participants	31	7.68	2.44				
Non-participants	34	7.53	2.43				
Cohort 2				3.347	.001	.65	0.38 / 3.20
Participants	32	8.69	1.79				
Non-participants	50	6.90	3.05				
Cohort 3				--	--	--	--
Participants	--	--	--				
Non-participants	--	--	--				
Expectations of ISU course difficulty (single-item scale)							
All cohorts				0.688	.492	--	-0.35 / 0.61
Participants	118	7.00	1.55				
Non-participants	172	6.87	1.56				
Cohort 1				0.075	.941	--	-0.88 / 0.93
Participants	38	6.84	1.41				
Non-participants	49	6.82	1.81				
Cohort 2				0.631	.530	--	-0.61 / 1.00
Participants	47	6.98	1.66				
Non-participants	56	6.79	1.40				
Cohort 3				0.686	.495	--	-0.65 / 1.11
Participants	33	7.21	1.58				
Non-participants	67	6.99	1.51				

Certainty of maintaining nontraditional major data not available for Cohort 3.
Note: Alpha, using a Bonferroni correction, equals 0.008.

Support and Encouragement

Further, the study predicted that the LLC participants would report greater support and encouragement to enter nontraditional fields than the non-participants. Multi-item and single item scales were used to assess for differences in role model support between the two groups. Respondents' Role Model Influence Scale (RMIS) scores were tallied into a total score assessing overall support, a score indicating overall support from their immediate family members, and a score noting overall support from females in their lives. In addition, individual item scores were analyzed for the following role models: male teachers, female teachers, male friends, and female friends. Results of these analyses are presented in Table 4.9. Contrary to the hypothesis, the analyses revealed only one difference between the two groups in support and encouragement to enter nontraditional fields. LLC participants within Cohort 3 reported greater support from their friends and family in choosing a nontraditional major than non-participants. Overall, both of the groups reported relatively high levels of support encouragement from individuals in their lives.

Academic Performance and Retention Analyses

The current study predicted that participants in the LLC would achieve higher collegiate grades than the non-participants. Academic grades were tallied for each group within each academic year and for cumulative grade point average, and the results are presented in Table 4.10. No significant differences were found between the groups on any academic performance variable. The profiles for both groups were quite flat, indicating that respondents performed equally and uniformly throughout their academic careers thus far. Paired comparison analyses were used to assess the relationship between all respondents' first-year grade point averages and cumulative grade point averages. As indicated in Table 4.11, these analyses demonstrated that the cumulative grade point average for Cohort 1

Table 4.9

Means, Standard Deviations, and t Values for Comparison of Participant Groups on Support and Encouragement Scales

Scale	N	Mean	SD	t	p-value	Effect Size	99.5% Confidence Interval
Confidence of Receiving Support within Scientific Fields (multi-item scale)							
All cohorts				1.791	.074	.21	-0.17 / 0.90
Participants	120	6.94	1.69				
Non-participants	173	6.57	1.80				
Cohort 1				-0.190	.850	--	-1.00 / 0.87
Participants	40	7.43	1.75				
Non-participants	49	7.49	1.55				
Cohort 2				1.331	.186	--	-0.46 / 1.40
Participants	47	6.61	1.71				
Non-participants	56	6.14	1.87				
Cohort 3				1.685	.096	.34	-0.32 / 1.42
Participants	33	6.80	1.48				
Non-participants	68	6.25	1.67				
Amount of support from friends & family in choice of major (single-item scale)							
All cohorts				0.990	.323	--	-0.39 / 0.87
Participants	96	8.81	1.93				
Non-participants	152	8.57	1.74				
Cohort 1				-0.450	.655	--	-1.54 / 1.09
Participants	31	8.48	2.16				
Non-participants	34	8.71	1.78				
Cohort 2				-0.055	.956	--	-1.30 / 1.24
Participants	32	8.59	2.31				
Non-participants	50	8.62	1.71				
Cohort 3				3.072	.003	.53	0.12 / 1.60
Participants	33	9.33	1.05				
Non-participants	68	8.47	1.76				

Table 4.9 continued

Scale	N	Mean	SD	t	p-value	Effect Size	99.5% Confidence Interval
Percentage of female professors in sci, math, & engr. (single-item scale)							
All cohorts				-1.504	.134	--	-6.69 / 1.78
Participants	116	10.10	12.96				
Non-participants	172	12.55	14.45				
Cohort 1				-0.916	.363	--	-12.47 / 6.04
Participants	37	13.70	14.81				
Non-participants	48	16.92	17.52				
Cohort 2				-0.991	.324	--	-9.14 / 4.13
Participants	47	8.48	11.74				
Non-participants	56	10.98	13.91				
Cohort 3				-0.964	.339	--	-9.21 / 4.31
Participants	32	8.31	11.88				
Non-participants	68	10.76	11.83				
Overall Support (Role Model Influence Scale)							
All cohorts				0.227	.821	--	-4.10 / 4.89
Participants	120	96.24	14.99				
Non-participants	172	95.85	13.92				
Cohort 1				-0.938	.351	--	-11.98 / 5.70
Participants	40	95.48	16.96				
Non-participants	49	98.61	14.00				
Cohort 2				0.881	.380	--	-4.72 / 9.48
Participants	47	97.00	13.82				
Non-participants	55	94.62	13.36				
Cohort 3				0.406	.686	--	-6.87 / 9.34
Participants	33	96.09	14.46				
Non-participants	68	94.85	14.23				
Overall Family Support (Role Model Influence Scale)							
All cohorts				0.596	.551	--	-1.18 / 1.88
Participants	120	19.33	5.06				
Non-participants	172	18.98	4.78				
Cohort 1				-0.544	.588	--	-3.59 / 2.36
Participants	40	18.88	5.01				
Non-participants	49	19.49	5.65				
Cohort 2				1.277	.205	--	-1.36 / 3.94
Participants	47	19.72	5.37				
Non-participants	55	18.44	4.71				
Cohort 3				0.284	.778	--	-2.30 / 2.85
Participants	33	19.33	4.75				
Non-participants	68	19.06	4.15				

Table 4.9 continued

Scale	N	Mean	SD	t	p-value	Effect Size	99.5% Confidence Interval
Overall Female Support (Role Model Influence Scale)							
All cohorts				0.250	.803	--	-1.79 / 2.17
Participants	120	30.40	6.30				
Non-participants	172	30.21	6.56				
Cohort 1				-0.814	.418	--	-4.96 / 2.63
Participants	40	30.75	7.21				
Non-participants	49	31.92	6.12				
Cohort 2				0.787	.433	--	-2.32 / 4.30
Participants	47	29.57	6.09				
Non-participants	55	28.58	6.64				
Cohort 3				0.695	.489	--	-2.40 / 4.12
Participants	33	31.15	5.41				
Non-participants	68	30.29	6.56				
Male Teacher Support (Role Model Influence Scale)							
All cohorts				1.187	.236	--	-0.21 / 0.55
Participants	117	5.57	1.15				
Non-participants	168	5.40	1.30				
Cohort 1				0.057	.955	--	-0.66 / 0.69
Participants	39	5.67	1.11				
Non-participants	46	5.65	1.25				
Cohort 2				0.235	.815	--	-0.58 / 0.69
Participants	46	5.46	1.19				
Non-participants	55	5.40	1.23				
Cohort 3				1.492	.140	--	-0.31 / 1.11
Participants	32	5.63	1.18				
Non-participants	67	5.22	1.38				
Female Teacher Support (Role Model Influence Scale)							
All cohorts				0.850	.396	--	-0.25 / 0.50
Participants	113	5.52	1.15				
Non-participants	163	5.40	1.23				
Cohort 1				0.011	.991	--	-0.66 / 0.66
Participants	39	5.64	1.18				
Non-participants	47	5.64	1.13				
Cohort 2				0.728	.469	--	-0.48 / 0.85
Participants	43	5.42	1.18				
Non-participants	51	5.24	1.26				
Cohort 3				0.643	.522	--	-0.51 / 0.83
Participants	31	5.52	1.09				
Non-participants	65	5.35	1.28				

Table 4.9 continued

Scale	N	Mean	SD	t	p-value	Effect Size	99.5% Confidence Interval
Male Friend Support (Role Model Influence Scale)							
All cohorts				-0.059	.953	--	-0.40 / 0.38
Participants	118	5.64	1.26				
Non-participants	170	5.65	1.23				
Cohort 1				0.420	.676	--	-0.59 / 0.82
Participants	39	5.82	1.34				
Non-participants	48	5.71	1.11				
Cohort 2				0.020	.984	--	-0.61 / 0.62
Participants	47	5.53	1.14				
Non-participants	55	5.53	1.21				
Cohort 3				-0.422	.674	--	-0.90 / 0.65
Participants	32	5.59	1.36				
Non-participants	67	5.72	1.32				
Female Friend Support (Role Model Influence Scale)							
All cohorts				0.599	.550	--	-0.28 / 0.45
Participants	118	5.74	1.14				
Non-participants	170	5.65	1.22				
Cohort 1				0.724	.471	--	-0.49 / 0.86
Participants	39	5.87	1.17				
Non-participants	48	5.69	1.19				
Cohort 2				-0.253	.801	--	-0.66 / 0.54
Participants	47	5.55	1.14				
Non-participants	54	5.61	1.16				
Cohort 3				0.720	.474	--	-0.49 / 0.85
Participants	32	5.84	1.11				
Non-participants	68	5.66	1.31				

Note: Alpha, using a Bonferroni correction, equals 0.005.

was significantly higher than the cohort's first-year grade point average. Cohorts 2 and 3 exhibited no significant differences in these analyses. Other analyses revealed that Cohorts 1 and 2 had significantly lower grade expectations after studying one year at the university. Both cohorts reported that when they entered the university they hoped to achieve between an A- and B+ grade point average; at the end of their first year of college both cohorts

Table 4.10

Means, Standard Deviations, and t Values for Comparison of Participant Groups on Academic Performance

Variable	N	Mean	SD	t	p-value	98.75% Confidence Interval
First-year GPA						
All cohorts				-0.230	.818	-0.23 / 0.19
Participants	142	2.73	0.71			
Non-participants	195	2.75	0.77			
Cohort 1				-1.114	.268	-0.57 / 0.23
Participants	40	2.66	0.70			
Non-participants	49	2.83	0.74			
Cohort 2				-0.170	.866	-0.34 / 0.30
Participants	60	2.78	0.73			
Non-participants	69	2.80	0.67			
Cohort 3				0.540	.591	-0.31 / 0.47
Participants	42	2.74	0.71			
Non-participants	77	2.66	0.87			
Second-year GPA						
All cohorts				-0.579	.564	-0.34 / 0.21
Participants	91	2.83	0.72			
Non-participants	101	2.90	0.74			
Cohort 1				-0.448	.655	-0.51 / 0.36
Participants	38	2.79	0.71			
Non-participants	43	2.86	0.79			
Cohort 2				-0.380	.705	-0.41 / 0.31
Participants	53	2.87	0.73			
Non-participants	58	2.92	0.71			
Cohort 3				--	--	--
Participants	--	--	--			
Non-participants	--	--	--			
Third-year GPA						
All cohorts				0.402	.689	-0.29 / 0.39
Participants	34	3.14	0.53			
Non-participants	41	3.09	0.59			
Cohort 1				0.402	.689	-0.29 / 0.39
Participants	34	3.14	0.53			
Non-participants	41	3.09	0.59			
Cohort 2				--	--	--
Participants	--	--	--			
Non-participants	--	--	--			
Cohort 3				--	--	--
Participants	--	--	--			
Non-participants	--	--	--			

Table 4.10 continued

Variable	N	Mean	SD	t	p-value	98.75% Confidence Interval
Cumulative GPA						
All cohorts				0.486	.627	-0.16 / 0.23
Participants	138	2.84	0.64			
Non-participants	190	2.80	0.72			
Cohort 1				-0.385	.702	-0.35 / 0.26
Participants	35	3.00	0.47			
Non-participants	39	3.05	0.52			
Cohort 2				-0.089	.929	-0.31 / 0.29
Participants	61	2.80	0.67			
Non-participants	71	2.82	0.65			
Cohort 3				0.566	.573	-0.29 / 0.45
Participants	42	2.75	0.70			
Non-participants	80	2.67	0.82			

Note: Alpha, using a Bonferroni correction, equals 0.0125.

stated that achieving a B grade point average was satisfactory.

It was predicted that LLC participants would be retained at the university and within nontraditional academic majors at a higher rate than LLC non-participants. Chi-square analyses revealed no significant differences between groups on university retention, although a greater percentage of LLC members than nonmembers were retained among all cohorts. As indicated in Table 4.12, both groups were retained at a relatively high level overall, with retention percentages ranging from 69.6 to 97.7 (Median for both groups = 89.7). Table 4.13 indicates that both groups exhibited higher university retention rates than female students overall and male and female students within each academic college.

Several significant differences were found between the groups on retention in nontraditional majors, as indicated in Table 4.12. Among all cohorts combined, retention following the students' first academic year was significantly higher among LLC participants than non-participants and this variable nearly reached significance following the students' second year. No significant difference was found in third-year retention data. Although no

Table 4.11

Means, Standard Deviations, and t Values for Paired Comparisons Within Cohorts of All Respondents on Academic Performance and Grade Expectations

Scale Item	N	Mean	SD	t	p-value	Effect Size	98.75% Confidence Interval
GPA							
Cohort 1				-4.858	.000	.34	0.29 / 0.09
First-year GPA	70	2.86	0.62				
Cumulative GPA	70	3.05	0.49				
Cohort 2				-1.218	.226	--	-0.08 / 0.03
First-year GPA	129	2.79	0.69				
Cumulative GPA	129	2.82	0.66				
Cohort 3				--	--	--	--
First-year GPA	122	2.70	0.78				
Grade Expectations							
Cohort 1				-10.10	.000	.89	1.46 / 0.98
Time 1	87	2.61	1.30				
Time 2	87	3.83	1.43				
Cohort 2				-9.438	.000	.84	1.44 / 0.94
Time 1	100	2.80	1.29				
Time 2	100	3.99	1.53				
Cohort 3				--	--	--	--
Time 2	101	3.91	1.54				

Note: Alpha, using a Bonferroni correction, equals 0.0125.
Grade expectations: 1= A grade point average, 2=A-, 3=B+, 4=B, 5=B-, 6=C+, 7=C, 8=less than a C average.

significant differences in nontraditional academic major retention were found between groups in Cohorts 1 and 3, Cohort 2 demonstrated significantly higher retention following the students' first and second academic years. Overall, nontraditional academic major retention rates were relatively high in both groups and ranged from 56.1% to 89.5% (Median for both groups = 75.9); at the same time, the LLC participants achieved higher retention percentage rates than non-participants within each cohort for each year of the study. Table 4.13 indicates that LLC participants achieved higher discipline retention rates than male and female students within each academic college, while the non-participant group retention

Table 4.12

Frequencies, Percentages, and Chi-square Values for Comparison of Participant Groups on University and Academic Major Retention

Scale Item	N	Number Retained	Percentage Retained	Chi-square	p-value	99.7% Confidence Interval
First-year ISU retention						
All cohorts				3.105	.078	-0.14 / 0.03
Participants	149	141	94.6			
Non-participants	207	185	89.7			
Cohort 1				0.952	.329	-0.24 / 0.12
Participants	45	42	93.3			
Non-participants	56	49	87.5			
Cohort 2				0.168	.682	-0.16 / 0.12
Participants	61	57	93.4			
Non-participants	71	65	91.5			
Cohort 3				2.982	.084	-0.22 / 0.04
Participants	43	42	97.7			
Non-participants	80	71	88.8			
Second-year ISU retention						
All cohorts				0.495	.482	-0.16 / 0.10
Participants	106	95	89.6			
Non-participants	127	110	86.6			
Cohort 1				0.044	.834	-0.14 / 0.12
Participants	45	43	95.6			
Non-participants	56	53	94.6			
Cohort 2				0.562	.453	-0.25 / 0.15
Participants	61	52	85.2			
Non-participants	71	57	80.3			
Third-year ISU retention						
All cohorts				0.843	.359	-0.35 / 0.19
Participants	45	35	77.8			
Non-participants	56	39	69.6			
Cohort 1				0.843	.359	-0.35 / 0.19
Participants	45	35	77.8			
Non-participants	56	39	69.6			
First-year Major Retention						
All cohorts				11.496	.001	0.30 / 0.02
Participants	143	122	85.3			
Non-participants	189	131	69.3			
Cohort 1				0.721	.396	-0.35 / 0.20
Participants	44	35	79.5			
Non-participants	50	36	72.0			
Cohort 2				12.864	.000	0.51 / 0.06
Participants	57	51	89.5			
Non-participants	67	41	61.2			
Cohort 3				1.832	.176	-0.34 / 0.12
Participants	42	36	85.7			
Non-participants	71	54	76.0			

Table 4.12 continued

Scale Item	N	Number Retained	Percentage Retained	Chi-square	p-value	99.7% Confidence Interval
Second-year Major Retention						
All cohorts				7.892	.005	-0.38 / 0.01
Participants	89	72	80.9			
Non-participants	101	63	62.4			
Cohort 1				0.277	.599	-0.36 / 0.25
Participants	37	28	75.7			
Non-participants	44	31	70.5			
Cohort 2				10.445	.001	0.54 / 0.03
Participants	52	44	84.6			
Non-participants	57	32	56.1			
Third-year Major Retention						
All cohorts				0.276	.599	-0.37 / 0.26
Participants	35	27	77.1			
Non-participants	39	28	71.8			
Cohort 1				0.276	.599	-0.37 / 0.26
Participants	35	27	77.1			
Non-participants	39	28	71.8			

Note: Alpha, using a Bonferroni correction, equals 0.003.

Table 4.13

Percentages of University Students and Participant Groups on University and College Discipline Retention

Group	First-year University Retention Rates	First-year College Discipline Retention Rates
LLC		
Participants	94.6	85.3
Non-participants	89.7	69.3
University Women	83.0	--
ISU Colleges		
Agriculture	87.0	78.0
Business	82.0	72.0
Design	83.0	62.0
Education	82.0	69.0
Engineering	88.0	72.0
Family & Consumer Sciences	82.0	70.0
Liberal Arts & Sciences	81.0	60.0

rates were average in comparison to the students in each academic college.

Changes in Adjustment, Self-Efficacy, and Support for LLC Participants Across Time

It was predicted that those residing in the LLC would demonstrate increasing adjustment, confidence, self-efficacy, and support throughout their collegiate experience. This was assessed with multiple administrations of the multi-item scales used to test for differences between LLC participants and non-participants in earlier analyses. Paired comparisons were made between each cohort's first-year follow-up questionnaire and the most recent follow-up questionnaire. As discussed in Chapter 3, scales assessing personal adjustment, confidence of academic achievement, and confidence of receiving support within technical fields were altered following the first cohort's initial follow-up questionnaire. Data from the revised second follow-up questionnaire for Cohort 1 were used in place of the first follow-up questionnaire in the paired comparisons analyses. Cohort 3 completed only one follow-up questionnaire, and descriptive statistics were computed in place of paired comparison analyses.

Results of these analyses are presented in Tables 4.14 and 4.15. Contrary to the hypothesis, no significant differences were found between the two administrations. All three cohorts reported relatively high levels of adjustment, confidence, self-efficacy, and role model support, as found in earlier analyses.

Retention Prediction

Logistic regression analyses were performed to determine if any combination of background and performance variables predicted retention at the university or in science, math, or engineering majors. Based on previous research of predictors, several variables were analyzed as individual predictors of retention. Results of these analyses are presented in Tables 4.16 and 4.17. The individual variables that were significantly associated with university retention and nontraditional academic major retention were

Table 4.14

Means, Standard Deviations, and t Values for Paired Comparisons Within Cohorts of LLC Participants on Adjustment and Efficacy Multi-item Scales

Scale	N	Mean	SD	t	p-value	Effect Size	99.7% Confidence Interval
Self-confidence in Academic Skills							
Cohorts 1 & 2				1.749	.087	.21	-0.06 / 0.28
Time 1	51	3.70	0.56				
Time 2	51	3.81	0.50				
Cohort 1				0.341	.737	--	-0.28 / 0.35
Time 1	18	3.87	0.61				
Time 2	18	3.91	0.56				
Cohort 2				1.925	.063	.31	-0.06 / 0.37
Time 1	33	3.61	0.51				
Time 2	33	3.76	0.46				
Cohort 3				--	--	--	--
Time 1	33	3.61	0.47				
Confidence of Academic Achievement							
Cohorts 1 & 2				0.269	.789	--	-0.39 / 0.47
Time 1	52	8.49	1.43				
Time 2	52	8.53	1.11				
Cohort 1				0.870	.396	--	-0.33 / 0.62
Time 1	19	8.61	1.28				
Time 2	19	8.75	1.01				
Cohort 2				-0.064	.949	--	-0.66 / 0.63
Time 1	33	8.41	1.52				
Time 2	33	8.40	1.15				
Cohort 3				--	--		--
Time 1	33	8.08	1.73				
Confidence of Receiving Support within Scientific Fields							
Cohorts 1 & 2				0.307	.760	--	-0.60 / 0.76
Time 1	52	7.04	1.47				
Time 2	52	7.11	1.59				
Cohort 1				0.105	.918	--	-1.28 / 1.37
Time 1	19	7.31	1.57				
Time 2	19	7.36	1.54				
Cohort 2				0.311	.758	--	-0.75 / 0.94
Time 1	33	6.88	1.42				
Time 2	33	6.97	1.62				
Cohort 3				--	--	--	--
Time 1	33	6.80	1.48				

Table 4.14 continued

Scale	N	Mean	SD	t	p-value	Effect Size	99.7% Confidence Interval
Personal Adjustment							
Cohorts 1 & 2				0.599	.552	--	-0.19 / 0.31
Time 1	52	3.93	0.59				
Time 2	52	3.99	0.55				
Cohort 1				1.336	.198	--	-0.24 / 0.65
Time 1	19	3.94	0.62				
Time 2	19	4.15	0.53				
Cohort 2				-0.255	.800	--	-0.35 / 0.29
Time 1	33	3.93	0.59				
Time 2	33	3.90	0.55				
Cohort 3				--	--		--
Time 1	33	3.96	0.67				
MSE							
Cohorts 1 & 2				0.259	.797	--	-0.27 / 0.33
Time 1	49	7.98	1.19				
Time 2	49	8.01	1.26				
Cohort 1				0.175	.863	--	-0.43 / 0.49
Time 1	18	8.09	1.30				
Time 2	18	8.12	1.37				
Cohort 2				0.194	.847	--	-0.40 / 0.46
Time 1	31	7.91	1.14				
Time 2	31	7.94	1.20				
Cohort 3				--	--	--	--
Time 1	31	7.27	1.24				
SSE							
Cohorts 1 & 2				0.663	.511	--	-0.29 / 0.48
Time 1	48	6.85	1.45				
Time 2	48	6.94	1.71				
Cohort 1				0.178	.861	--	-0.52 / 0.59
Time 1	17	6.94	1.65				
Time 2	17	6.97	1.88				
Cohort 2				0.649	.521	--	-0.42 / 0.68
Time 1	31	6.80	1.36				
Time 2	31	6.93	1.64				
Cohort 3				--	--	--	--
Time 1	31	6.48	1.67				

Note: Alpha, using a Bonferroni correction, equals 0.003.

Table 4.15

Means, Standard Deviations, and t Values for Paired Comparisons Within Cohorts of LLC Participants on Role Model Support Scales

Scale Item	N	Mean	SD	t	p-value	Effect Size	99.7% Confidence Interval
Overall Support							
Cohorts 1 & 2				0.691	.493	--	-3.64 / 6.18
Time 1	52	96.56	13.59				
Time 2	52	95.29	14.42				
Cohort 1				0.131	.897	--	-9.91 / 10.86
Time 1	19	94.84	14.52				
Time 2	19	94.37	13.87				
Cohort 2				0.839	.408	--	-3.91 / 7.37
Time 1	33	97.55	13.15				
Time 2	33	95.82	14.91				
Cohort 3				--	--	--	--
Time 1	33	96.09	14.46				
Overall Family Support							
Cohorts 1 & 2				0.768	.446	--	-0.95 / 1.72
Time 1	52	19.56	4.72				
Time 2	52	19.17	4.69				
Cohort 1				0.079	.938	--	-1.87 / 1.98
Time 1	19	18.63	4.21				
Time 2	19	18.58	3.92				
Cohort 2				0.830	.413	--	-1.32 / 2.48
Time 1	33	20.09	4.98				
Time 2	33	19.52	5.11				
Cohort 3				--	--	--	--
Time 1	33	19.33	4.75				
Overall Female Support							
Cohorts 1 & 2				-0.100	.921	--	-2.67 / 2.48
Time 1	52	29.88	6.15				
Time 2	52	29.79	6.71				
Cohort 1				0.089	.930	--	-4.96 / 5.27
Time 1	19	29.16	6.98				
Time 2	19	29.32	5.62				
Cohort 2				-0.213	.833	--	-3.36 / 2.88
Time 1	33	30.30	5.70				
Time 2	33	30.06	7.33				
Cohort 3				--	--	--	--
Time 1	33	31.15	5.41				

Table 4.15 continued

Scale Item	N	Mean	SD	t	p-value	Effect Size	99.7% Confidence Interval
Male Teacher Support							
Cohorts 1 & 2				0.000	1.00	--	-0.42 / 0.42
Time 1	51	5.45	1.35				
Time 2	51	5.45	1.14				
Cohort 1				-.0547	.591	--	-0.99 / 0.67
Time 1	19	5.42	1.57				
Time 2	19	5.26	1.19				
Cohort 2				0.501	.620	--	-0.42 / 0.61
Time 1	32	5.47	1.22				
Time 2	32	5.56	1.11				
Cohort 3				--	--	--	--
Time 1	32	5.63	1.18				
Female Teacher Support							
Cohorts 1 & 2				-0.813	.420	--	-0.57 / 0.31
Time 1	45	5.58	1.12				
Time 2	45	5.44	1.12				
Cohort 1				-1.046	.312	--	-1.19 / 0.57
Time 1	16	5.69	1.25				
Time 2	16	5.38	1.15				
Cohort 2				-0.177	.861	--	-0.57 / 0.51
Time 1	29	5.52	1.06				
Time 2	29	5.48	1.12				
Cohort 3				--	--	--	--
Time 1	31	5.52	1.09				
Male Friend Support							
Cohorts 1 & 2				0.707	.483	--	-0.38 / 0.66
Time 1	51	5.49	1.17				
Time 2	51	5.63	1.13				
Cohort 1				-0.156	.878	--	-1.02 / 0.92
Time 1	19	5.63	1.26				
Time 2	19	5.58	1.17				
Cohort 2				1.052	.301	--	-0.40 / 0.90
Time 1	32	5.41	1.13				
Time 2	32	5.66	1.12				
Cohort 3				--	--	--	--
Time 1	32	5.59	1.36				

Table 4.15 continued

Scale Item	N	Mean	SD	t	p-value	Effect Size	99.7% Confidence Interval
Female Friend Support							
Cohorts 1 & 2				0.111	.912	--	-0.45 / 0.49
Time 1	51	5.75	1.09				
Time 2	51	5.76	0.93				
Cohort 1				-1.278	.217	--	-1.20 / 0.46
Time 1	19	5.84	1.26				
Time 2	19	5.47	0.96				
Cohort 2				1.161	.255	--	-0.34 / 0.84
Time 1	32	5.69	1.00				
Time 2	32	5.94	0.88				
Cohort 3				--	--	--	--
Time 1	32	5.84	1.11				

Note: Alpha, using a Bonferroni correction, equals 0.003.

entered together into logistic regression equations predicting university retention and major retention.

The model significantly predicted university retention ($\chi^2(20, N = 164) = 45.21, p = .001$) with an overall correct prediction percentage of 90.85, as demonstrated in Table 4.18. Table 4.19 indicates that six variables were significant in this prediction model. Positive associations were found between university retention and the following variables: number of acquaintances at the university, parents remaining married, education levels of respondents' mothers, education levels of respondents' female family members overall, ACT-science reasoning scores, and the Self-Confidence in Academic Skills Scale. The direction of associations between retention and the variables used in the model were found to be affected by the other variables in the model; thus, the true direction of the effects were determined from the bivariate analyses reported in Table 4.16.

As indicated in Table 4.20, the model also significantly predicted nontraditional academic major retention ($\chi^2(15, N = 218) = 49.82, p = .0000$) with an overall correct

Table 4.16

Variables Used to Predict University Retention in Logistic Regression Analyses

Variable	Chi-square for University Retention	p-value for University Retention
Race	2.607	.11
Hometown	3.272	.07
Level of education anticipated	2.986	.08
Acquaintances at ISU	5.651	.02
Acquaintances in sci, engr. major	5.179	.02
Acquaintances in residence hall	2.906	.09
Parents' marital status	8.341	.00
Father's education	9.946	.00
Mother's education	6.825	.01
Maternal grandmother's education	2.545	.11
Paternal grandmother's education	0.926	.34
Aunt's education	4.295	.04
Female family education summary	8.025	.00
Father's employment status	0.331	.57
Mother's employment status	0.918	.34
Scientist/engr. acquaintances	1.181	.28
Female math/science teachers	0.375	.54
Support total score (general)	1.843	.17
Support total score (in sci, engr.)	1.697	.19
LLC membership	2.196	.14
HS rank	13.902	.00
First-year GPA	26.158	.00
ACT-composite	15.984	.00
ACT-English	7.807	.01
ACT-math	8.777	.00
ACT-reading	12.040	.00
ACT-science reasoning	14.012	.00
Math Self-Efficacy Scale	9.928	.00
Science Self-Efficacy Scale	8.532	.00
Self-Confidence in Academic Skills Scale	8.510	.00
Personal Adjustment Scale	3.983	.05
Confidence in Academic Achievement Scale	7.289	.01
Confidence of Within Field Support Scale	10.732	.00
Family support for entering sci, engr.	1.123	.29
Female support for entering sci, engr.	2.343	.13
Male teacher support for entering sci, engr.	1.496	.22
Female teacher support for entering sci, engr.	1.021	.31

Note: For all variables df = 1.

Table 4.17

Variables Used to Predict Major Retention in Logistic Regression Analyses

Variable	Chi-square for Major Retention	p-value for Major Retention
Race	0.103	.75
Hometown	3.535	.06
Level of education anticipated	0.442	.51
Acquaintances at ISU	1.006	.32
Acquaintances in sci, engr. major	0.995	.32
Acquaintances in residence hall	0.265	.61
Parents' marital status	1.499	.22
Father's education	3.137	.08
Mother's education	0.582	.45
Maternal grandmother's education	2.647	.10
Paternal grandmother's education	0.160	.69
Aunt's education	2.053	.15
Female family education summary	2.484	.12
Father's employment status	0.568	.45
Mother's employment status	0.245	.62
Scientist/engr. acquaintances	4.708	.03
Female math/science teachers	1.360	.24
Support total score (general)	0.704	.40
Support total score (in sci, engr.)	3.093	.08
LLC membership	8.989	.00
HS rank	9.242	.00
First-year GPA	3.958	.05
ACT-composite	8.347	.00
ACT-English	1.211	.27
ACT-math	15.277	.00
ACT-reading	3.702	.05
ACT-science reasoning	12.143	.00
Math Self-Efficacy Scale	7.800	.01
Science Self-Efficacy Scale	12.314	.00
Self-Confidence in Academic Skills Scale	2.411	.12
Personal Adjustment Scale	1.048	.31
Confidence in Academic Achievement Scale	1.048	.31
Confidence of Within Field Support Scale	12.439	.00
Family support for entering sci, engr.	14.225	.00
Female support for entering sci, engr.	13.732	.00
Male teacher support for entering sci, engr.	10.275	.00
Female teacher support for entering sci, engr.	8.228	.00

Note: For all variables df = 1.

Table 4.18

Classification Table for University Retention Using Twenty-one Significant Predictors

		Predicted		
		Attrition	Retention	Percent Correct
Observed	Attrition	3	12	20.00
	Retention	3	146	97.99
			Overall	90.85

Table 4.19

Regression Values for the Full Model Predicting University Retention

Variable	Beta	Chi-square	p-value
Acquaintances at ISU	0.19	5.017	.03
Acquaintances in sci, engr. major	-0.18	2.040	.15
Parents' marital status	-2.10	4.148	.04
Father's education	-0.44	0.217	.64
Mother's education	-4.96	4.523	.03
Aunt's education	-4.02	3.190	.07
Female family education summary	4.56	5.181	.03
HS rank	0.03	0.297	.59
First-year GPA	1.24	2.147	.12
ACT-composite	-0.20	0.065	.80
ACT-English	-0.15	0.338	.56
ACT-math	0.40	1.667	.20
ACT-reading	0.11	0.269	.60
ACT-science reasoning	0.66	4.211	.04
Math Self-Efficacy Scale	0.52	0.970	.32
Science Self-Efficacy Scale	-0.13	0.084	.77
Self-Confidence in Academic Skills Scale	-4.12	6.627	.01
Personal Adjustment Scale	0.90	1.019	.31
Confidence in Academic Achievement Scale	0.05	0.018	.89
Confidence of Within Field Support Scale	0.64	3.500	.06

prediction percentage of 83.49. Seven variables were significant in the prediction model, and positive associations were found between retention and the following variables: LLC membership, ACT-composite scores, ACT-math scores, ACT-reading scores, ACT-science reasoning scores, the Math Self-Efficacy Scale, and the Science Self-Efficacy Scale. These results are presented in Table 4.21. As with the model predicting university retention, the

Table 4.20

Classification Table for Nontraditional Major Retention Using Fifteen Significant Predictors

		Predicted		
		Attrition	Retention	Percent Correct
Observed	Attrition	17	29	36.96
	Retention	7	165	95.93
			Overall	83.49

Table 4.21

Regression Values for the Full Model Predicting Nontraditional Major Retention

Variable	Beta	Chi-square	p-value
Scientist/engr. acquaintances	0.02	0.280	.60
LLC membership	1.41	9.883	.00
HS rank	0.03	1.485	.22
First-year GPA	-0.09	0.056	.81
ACT-composite	-0.66	7.960	.00
ACT-math	0.35	10.730	.00
ACT-reading	0.19	5.079	.02
ACT-science reasoning	0.29	6.034	.01
Math Self-Efficacy Scale	-0.61	4.843	.03
Science Self-Efficacy Scale	0.58	7.457	.01
Confidence of Within Field Support Scale	0.03	0.032	.86
Family support for entering sci, engr.	0.04	0.379	.54
Female support for entering sci, engr.	0.05	1.000	.32
Male teacher support for entering sci, engr.	0.11	0.290	.59
Female teacher support for entering sci, engr.	-0.06	0.056	.81

variables included in the regression model affected the direction of associations for other variables. The accurate directions of the associations were determined from the values presented in Table 4.17.

Process Variables

The questionnaire administered to the LLC applicants only was analyzed to determine the order of factors influencing application to the LLC. Responses were combined across cohorts, and means and standard deviations of the items are presented in Table 4.22. As indicated, respondents rated eight of the ten factors as having moderate or higher influences on their decisions to apply to the LLC. Overall, developing friendships with others in nontraditional fields and accessing academic support groups were rated as having the greatest influence on the women's decisions to apply; knowing other students involved in the program and receiving encouragement by advisors were rated as being the least influential on the women's decisions.

Table 4.22

Means and Standard Deviations of Influencing Factors for Applying to the LLC

Scale Item	Mean	SD
Wanted to make friends with other students in my field	7.69	2.26
Having access to supportive study groups	7.07	2.54
More likely to get advice and information about possible careers in my field	6.92	2.78
Informal help or tutoring with difficult subjects	6.74	2.92
Wanted the academic enrichment	6.24	2.75
Wanted to live in a specific residence hall	6.11	3.20
Ability to participate in special workshops in my major area	5.59	2.84
Wanted to be part of a smaller group on campus	5.13	3.06
Knew someone else in the program	2.33	2.53
Was encouraged to participate in program by my advisor	2.11	2.14

DISCUSSION

Women continue to be underrepresented in traditionally male dominated academic majors and career fields despite comprising half of the United States college population and workforce (Betz & Fitzgerald, 1987; Geppert, 1995). Research has suggested several internal and external barriers that hamper women from entering and being retained in these nontraditional areas (Betz & Fitzgerald, 1987). Internal barriers include impediments such as incongruent interests (e.g., Betz & Fitzgerald, 1987; Betz & Hackett, 1981), lower aptitude and achievement performance than men (e.g., Lent, Lopez, & Bieschke, 1991; Hackett, Betz, Casas, & Rocha-Singh, 1992), and diminished self-efficacy (e.g., Betz & Fitzgerald, 1987; Chipman et al., 1992). External barriers cited as thwarting women's entry and retention in these fields include low social support from family, educators, and peers (e.g., Houser & Garvey, 1983, 1985; Meade, 1991), few role models (e.g., Hackett et al., 1989), and potential role conflict between family and career (e.g., Morgan, 1992; Ware & Lee, 1988).

In an attempt to address and eliminate these barriers, universities have begun to introduce interventions designed to encourage women to enter nontraditional academic majors and support these students throughout their collegiate experiences. Living Learning Centers (LLCs) have been implemented to house women from nontraditional academic majors together on residence hall floors to facilitate academic and social support within the participants. Although varied forms of LLCs have been in existence for 30 years (Pascarella, Terenzini, & Blimling, 1994), only recently have they been utilized with the population in the current study. Research has demonstrated that members of LLCs, when compared with students living in traditional residence halls, attain higher academic achievement (e.g., Pascarella & Terenzini, 1981; Kanoy & Bruhn, 1996), achieve greater retention within the university and within academic majors (e.g., Blimiling, 1993; Schroeder

& Griffin, 1976; Chapple, 1984), and exhibit better personal adjustment (e.g., Pascarella & Terenzini, 1980, 1981; Schroder & Belmonte, 1979).

The current study evaluated the effects of an LLC designed to decrease social isolation within women studying traditionally male-dominated career fields at Iowa State University. Secondary goals of the intervention included increasing LLC participants' retention within nontraditional academic majors and enhancing LLC participants' academic performance within nontraditional courses of study. Increasing LLC participants' university retention, overall academic performance, self-efficacy, and college adjustment were tertiary objectives. Consistent with recent research, this study hypothesized that the LLC participants would report higher grades, retention, academic and social confidence, support, and adjustment relative to a comparison group of women in nontraditional majors who did not apply to be members of the LLC. Further, the study hypothesized that the members of the LLC would report higher levels of these variables across the span of their college years when compared to their first year of college. Finally, the study investigated variables that predicted retention within all study respondents. The findings were mixed for each of the hypotheses, with some significant differences emerging between the groups.

Background Variables

Participants in the current study included women who applied to become members of the LLC and a comparison group of women who did not apply to the program. Randomization is not possible in research using this design due to ethical concerns of assigning students to living quarters without their informed consent (Schroeder, 1980). Due to concerns of applicant self-selection as a confounding variable, background analyses compared the applicant and non-applicant groups on variables that might have indicated pre-existing differences between the groups. First, p-values were analyzed using a relaxed alpha level of .20. Second, variables reaching this significance level were evaluated with

confidence intervals using a Bonferroni adjustment to maximize the width of the intervals to the "worst case scenario." None of the aptitude measures exhibited differences between the groups, and the minimal number of demographic variables that were detected at the relaxed alpha level were judged not to represent a meaningful pattern of pre-existing differences between applicants and non-applicants. Additional analyses confirmed that there were no differences within each cohort analyzed separately.

Outcome Variables

Adjustment, Self-Efficacy, and Support Differences in LLC Participants and Non-participants

Due to the concentration of women with nontraditional majors in the shared living environment, it was hypothesized that the participants of the LLC would experience an easier adjustment to college, express greater academic self-efficacy, and report greater support and encouragement than the comparison group. The present investigation only partly supported this hypothesis; no significant differences were found between the groups on the multi-item scales used to assess these variables. However, several single-item scales measuring campus involvement indicated that members of the LLC did feel more at ease in their surroundings, expressed higher academic confidence, and perceived greater support from others in pursuing a nontraditional major.

When comparing all members of the LLC to all non-participants across cohorts, members experienced less difficulty getting acquainted with others on their residence hall floors, members perceived greater commonalities with their floormates, a greater number of LLC members affirmed that they would choose to live on the same residence hall floor again, and a greater number of the LLC members indicated that they have joined or intend to join two campus organizations for women in science and engineering. Further, a nonsignificant trend indicated that members of the LLC reported greater certainty of maintaining their nontraditional academic majors than those not living in the LLC.

Analyses performed within each cohort on these variables revealed additional differences between the groups. In comparison to non-participants within Cohort 2, LLC members in Cohort 2 reported significantly greater desire to remain on the same residence hall than the cohort's non-participants, members were significantly more likely to have joined or intend to join the two campus organizations for women in science and engineering, and members were significantly more certain of maintaining a nontraditional academic major. Nonsignificant trends within Cohort 2 suggested that LLC members had less difficulty than non-participants getting to know their floormates and were less likely to join or intend to join a social sorority or the Honors program than non-participants. Within Cohort 3, LLC members reported significantly more support from friends and family members to choose a nontraditional academic major than reported by non-participants. Further, nonsignificant trends within the cohort indicated that in comparison to non-participants, LLC members reported more commonalities with floormates and were more likely to join the Association for Women in Science, one of the campus organizations for women in science and engineering.

While the results for adjustment, academic confidence, self-efficacy, and support were mixed, these findings lend some support for the benefits of the LLC intervention. The significant findings indicating greater adjustment within the LLC residence hall floors suggest high levels of congeniality and peer support for the women in the program. The current intervention was designed to decrease social isolation within its participants and these results suggest that this primary objective was achieved. These results support earlier research that found LLC members reported greater emotional support for residence hall mates, more group spirit than non-participants, and more requests to remain on the same residence hall (e.g., DeCoster, 1968; Schroeder and Griffin, 1976; Madson et al.,

1976; Magnarella, 1975; Pascarella & Terenzini, 1980; Golden & Smith, 1983; Arminio, 1994; Goldman & Hood, 1995).

Overall, students in the LLC were more likely to join or intend to join the campus organizations of the Society for Women Engineers and the Association for Women in Science. This indicates a greater desire to become involved on the university campus, and it supports previous studies that found LLC members were more involved in extracurricular campus activities (Schroeder & Griffin, 1976; Madson et al., 1976; Magnarella, 1975; McKelfresh, 1980). It appears that members of the LLC, particularly in Cohorts 2 and 3, felt encouraged to join organizations that provided additional peer support and leadership possibilities. This iterative cycle suggests LLC members felt supported and empowered to increase their involvement, which positively reinforced their interactions with peers and increased members' perceived peer social support.

Although there was not a significant difference between the groups across cohorts on certainty of maintaining a nontraditional academic major, members of the LLC tended to be more certain of their own retention than members of the comparison group. Additionally, LLC members within Cohort 2 did report greater certainty to maintain their academic majors than did non-participants. Indeed, several studies have indicated that members of LLCs report greater satisfaction with their academic programs than students in other residence halls (Pascarella & Terenzini, 1981; Pemberton, 1969; McKelfresh, 1980).

Although other academic confidence, self-efficacy, adjustment, and support scales did not significantly differentiate between the groups, both groups self-reported relatively high ratings for each variable. Because both groups of women perceived their personal development very positively, it may have been difficult for the groups to be significantly different. It is possible that the LLC was not an integral factor in their ratings of their personal development. At the same time, members of the LLC reported numerically higher

means within each scale than the non-participants. This could suggest that the LLC did have a positive effect on its members but significant differences did not emerge due to ceiling effects and the low number of participants available for the study. This will be discussed further as a limitation of the study.

Nearly twenty years have passed since much of the research was conducted in this area. Generational differences might help explain the discrepancy between some previous research and the non-significant findings in the current study; universities may have modified their objectives and opportunities, and students' expectations of the college setting may have changed. Past students may have relied on acquiring knowledge and skills in the classroom; students currently enrolled in college are expected to learn some skills, such as computer proficiency, fairly independently. It is possible that students are now entering the university setting with higher levels of independence and maturity and might not rely on programs such as LLCs to foster confidence, self-efficacy, or adjustment.

Academic Performance and Retention Analyses

Contrary to the study's hypothesis, the LLC group did not achieve higher grades than the comparison group. There were no differences between the groups on yearly or cumulative grade-point average. Differences were found in paired comparison analyses of first year grade-point average and cumulative grade-point average among those retained at the university. Cohort 1 exhibited a significant increase from their first year grade-point average to their cumulative grade-point average. No differences emerged within Cohort 2, although the numerical mean did increase from their first year grade-point average to their cumulative grade-point average.

These results do not fully support research that has found LLCs enhance academic performance within roommates (Crew & Giblette, 1965), first-year students (e.g., Pascarella & Terenzini, 1981), high ability students (DeCoster, 1966, 1968), women (Kanoy & Bruhn,

1996; Schroeder & Belmonte, 1979), and male engineering students (Taylor & Hanson, 1971; Schroeder & Griffin, 1976). Several variables might contribute to the unexpected finding that LLC members did not achieve higher academic performances than the non-participant group. First, the courses in which the women were enrolled may have differed in difficulty. The LLC participants may have been more confident of their career choices and delved into difficult prerequisite courses for their majors; the women who had not applied for the LLC may have been less committed to their selections of nontraditional majors and enrolled in general elective courses. As will be discussed later as a direction for future research, acquiring academic performance scores in specific nontraditional courses of study may provide more detailed information to better understand performance differences between participants and non-participants. Second, the number of hours spent studying may have varied among the respondents resulting in different grade outcomes between the groups. The programming offered by the LLC and the informal study groups formed within the LLC may have served as distractions for the women in the shared living environment and actually decreased the amount of time the LLC participants studied. The women outside of the LLC may not have experienced the same amount of distraction from their studies. Third, the LLC might have attracted women who desired a close social community and were more extroverted than the non-applicants. As discussed earlier, the LLC participants reported greater support and cohesion within their residence halls than was reported by the non-participants. Members of the LLC might have invested significant time and energy into establishing and maintaining college friendships; this investment might have reduced their attention to academics and diminished their academic performance. Whereas the intervention attained the primary goal of decreasing social isolation, this achievement may have inadvertently interfered with reaching the goal of increasing academic performance.

At the same time, two longitudinal studies have refuted the idea that LLCs enhance academic performance across the collegiate experience and have suggested that LLCs appear to have little influence on cumulative grade-point averages (Felver, 1983; Goldman & Dickerson, 1993). Although LLCs aim to retain their participants throughout their college years, many members leave the housing unit after a few years to live independently in off-campus housing. It is possible that the students did not avail themselves of the academic and social support offered within the LLC after they left the housing unit. This may partially explain there being no significant difference within academic achievement over the span of the participants' college experience. However, members of Cohort 1 did demonstrate an increase in academic achievement from their first year to their current cumulative grade-point average. This suggests that both participant groups in the sample performed well academically over the span of their college careers. Although the LLC did not appear to be an integral factor in academic achievement between participant groups, this cohort's high grades are an exciting finding for women in nontraditional academic majors. It seems that those women who were retained within the university continued to perform at a high level academically.

Other results showed that respondents in Cohorts 1 and 2 decreased their grade expectations over the course of their first year at the university. Although the grade expectations changed only slightly, from an A-/B+ range to a B grade-point average, they represented a significant shift in personal expectations. These results suggest that the students were able to reevaluate the demands they placed on themselves after adjusting to the college environment. It is possible that these women may remain in nontraditional fields if they have appropriately modified their academic performance expectations, as Meade (1991) and Ware et al. (1985) suggested.

While academic performance is important as it relates to women preparing for nontraditional fields, retention is often used as a benchmark of success by university administrators and individual students. It was hypothesized that participation in the LLC would increase retention both within the university and within nontraditional academic majors. Contrary to hypothesis, differences between the participant groups did not emerge on the variable of university retention. However, participants posted higher retention rates within each cohort and across all cohorts. Despite the higher percentages among LLC participants, the lack of significant differences appear to contradict previous research (e.g., Blimling, 1993; Chapple, 1984; Morishima, 1966; DeCoster, 1966, 1968). Both groups attained high retention rates at the university which may help explain the lack of differences between the groups. Furthermore, the retention rates of both groups were higher than the retention rates of women at the university and of students within each academic college. The high retention rates posted by both groups may not allow for a great deal of improvement; also, university administrators must remember that high retention is the ultimate goal, regardless of the intervention that facilitated achievement of the goal.

Specific to the present intervention, retention of women within nontraditional academic majors remained a main objective. While the current study found somewhat mixed results, it appears that some women in the LLC were retained at higher levels than the non-participant group. LLC participants achieved significantly higher retention percentages than non-participants across cohorts following their first academic year. A nearly significant trend indicated the same results following the students' second year. Further, the LLC participants in Cohort 2 demonstrated significantly higher retention rates than non-participants within the same cohort for the first two academic years. No differences were found for Cohorts 1 and 3 individually; however, the LLC participants posted numerically higher retention rates than non-participants within each cohort and in the

total sample. Also, the LLC participants attained higher retention rates than students in each academic college, whereas the non-participant group's retention rates were average in comparison to the retention rates within the academic colleges.

Several studies have reported positive effects of LLCs on retention within academic majors (Chapple, 1984; Schroeder & Griffin, 1976; Schroeder & Belmonte, 1979; Felver, 1983). The significant differences and numerically higher retention rates that emerged in the current study support this research. However, it appears that the significant difference and nonsignificant trend found across cohorts following the students' first and second academic years appear to be driven by the large differences found between participant groups within Cohort 2. This cohort effect suggests that Cohort 2 experienced unique retention circumstances. In comparison to the other cohorts, the non-participant group within Cohort 2 exhibited an extremely low retention rate within its first year at the university that was maintained throughout the years studied in the current evaluation. While several alterations were made within the LLC structure as the second cohort entered, there were no structural academic programming changes at the university that would have affected the non-participants differently than the participants. At the same time, the retention differences within the cohort cannot be explained by significant differences in adjustment, academic confidence, self-efficacy, support, and academic performance variables between participant groups. The differences may not be explained using quantitative data; it is possible that qualitative interviews with members of the non-participant group would yield information to clarify the high attrition rate within that group of the cohort.

Changes in Adjustment, Self-Efficacy, and Support for LLC Participants Across Time

The initial program evaluation of the current intervention suggested that differences did not emerge between the LLC members and the comparison group members in confidence, self-efficacy, adjustment, and role model support because too little time had

elapsed in their collegiate experiences (Gandhi, 1997). To assess whether additional time produced greater academic confidence, self-efficacy, adjustment, and support, the LLC members' most recent follow-up survey responses were compared with their initial follow-up survey responses. The current study hypothesized that respondents would report higher levels of these variables over the span of their collegiate experiences. However, no significant differences were found within the members of the cohorts.

Other longitudinal studies of LLCs have not investigated variables such as academic confidence, self-efficacy, or role model support. They have studied adjustment to the college environment by comparing the number of students within LLCs and traditional residence halls who remained on the same residence hall for an extended period of time (e.g., Schroeder & Griffin, 1976; Pascarella & Terenzini, 1980; Magnarella, 1975; DeCoster, 1968; Morishima, 1966). As indicated earlier, the current study's results did support these findings.

It is possible that the scales used in the current study did not fully capture the operational definitions of the academic confidence, self-efficacy, adjustment, and support variables. Although all scales used in the current study achieved high levels of internal consistency, many have not been used in published studies with this population. Despite demonstrating adequate psychometric properties, the scales may not satisfactorily assess the concepts of academic confidence, self-efficacy, adjustment, and support as defined by this unique population. This may explain in part why some explicitly worded adjustment single-item scales differentiated between the participant groups but the multi-item scales used in the longitudinal analyses did not exhibit differences over time within the members of the LLC.

It is possible also that the intervention did not effect change over time as predicted. The LLC provided some personal development programming but these offerings often

experienced low attendance by LLC members. The programming may have been too sporadic to foster increases in personal development or the program topics may not have addressed student needs. Academic tutoring, aimed at increasing levels of academic confidence and self-efficacy, may not have achieved this goal. The tutoring was offered in one-hour segments which may not have allowed enough time for students' needs. Homework problems in technical sciences and mathematics courses often consist of several parts which require much time to complete.

Although the LLC may not have been an integral factor in its members personal development, the current study found that LLC members reported relatively high levels of academic confidence, self-efficacy, adjustment, and support during both administrations of the follow-up questionnaire. However, due to these high scores, it is possible that the scales may be exhibiting a slight ceiling effect where the women generally perceive little potential increase in their levels of academic confidence, self-efficacy, adjustment, and support.

Retention Prediction

Logistic regression analyses revealed models that significantly predicted retention at the university and within nontraditional academic majors. The six variables that significantly predicted university retention were number of acquaintances at the university, education level of respondents' mothers, education level of female family members overall, ACT-science reasoning scores, the Self-Confidence in Academic Skills Scale, and parents remaining married. All were positively associated with university retention. All of these associations are consistent with previous research and most are intuitive. Parents' marital status as a predictor of retention may suggest that students from an intact family of origin experience greater financial and emotional stability, which may increase the chance that they will remain at the university. As discussed earlier, LLC membership did not

significantly affect university retention, and membership was not a significant predictor of this retention variable.

Seven variables significantly predicted nontraditional academic major retention in the regression model. LLC membership, ACT-composite score, ACT-math score, ACT-reading score, ACT-science reasoning score, the Math Self-Efficacy Scale, and the Science Self-Efficacy Scale all demonstrated positive associations with major retention. The relationships between these variables and retention in nontraditional academic majors support findings in previous studies.

Inconsistent with previous theory and research, several variables did not significantly contribute to predicting retention at the university or in nontraditional academic majors. The current study supported findings by Schaefers et al. (1997) that ACT-math scores predicted retention in nontraditional academic majors, but this investigation did not find that first-year grade-point average was a significant predictor, as Schaefers et al. (1997) found with first semester grade-point average. Further, Fassinger (1990) indicated high ability in high school predicted entrance into nontraditional fields. While ability may predict initial entry into these academic majors, the current study did not find that high school rank later predicted either retention variable.

It is somewhat surprising that only one variable assessing social support was a significant predictor of retention. Consistent with research by Simpson et al. (1980), higher numbers of university acquaintances was a predictor of university retention. However, despite respondents' high assessments of social support and role model influences, these variables did not appear to have a significant impact on respondents' retention rates at the university or in nontraditional academic majors. This highlights a void in the research performed with this population. Although a number of studies have investigated the effects of social support and role model influences on attracting women to nontraditional college

majors (e.g., Meade, 1991; Dick & Rallis, 1991; Betz & Fitzgerald, 1987), few studies have examined the impact of these variables on final retention rates at the college level. Research has demonstrated that social support and role models are necessary for this population, but the current study did not find support for these variables as significant predictors of retention.

Process Variables

The questionnaire administered to the LLC applicants asked the respondents to rate the influence of ten factors on their decision to apply to the LLC. The factors rated as most influential involved acquiring friends within nontraditional fields and accessing supportive study groups, and the factors rated as least influential involved encouragement to join the LLC by an academic advisor and knowing another LLC member. It appears that the students who entered the LLC viewed it as a mechanism toward integration into the social and academic environments at the university; this is in accord with the conceptualization of LLCs (Pascarella, Terenzini, & Blimling, 1994). The factors rated as least influential were not surprising; it is understandable that advisors are still becoming familiar with the program and applicants did not know any LLC members because students apply prior to entering the university community. This questionnaire seemed an effective measure of LLC enrollment factors; it appears that the LLC may attract additional applicants with increased publicity among students considering university enrollment and among academic advisors at the university.

Limitations of the Study and Suggestions for Continuing Research

As with any study, the present program evaluation has limitations. The primary limitation of the current investigation is the lack of generalizability to other university populations, most notably other LLCs. Research on other LLCs has demonstrated significant differences between LLC participants and comparison groups while this program

evaluation did not fully support these studies; the incongruent results with previous research particularly raises questions of the generalizability of the current investigation.

Also, the LLC studied in the current investigation differed from other LLCs in the population studied. The LLC was comprised of women in science, math, and engineering majors, a population that has not been studied previously. LLCs in earlier research have been composed of populations such as first year students with varying majors (Barnes, 1977; Elton & Bate, 1966; Morishima, 1966), high ability students (DeCoster, 1966, 1968; Stewart, 1980), forestry majors (Madson et al., 1976), and students of engineering across genders and several ages (McKelfresh, 1980; Schroeder & Griffin, 1976; Taylor & Hanson, 1971).

Another factor that distinguished the population studied in the current evaluation from previous investigations was the concentration of members in the LLC. During the first year of the intervention participants in the shared living environment were separated onto four residence hall floors and held percentages on the floors ranging from 4.9% to 46.8% (Median = 25.7%). The initial program evaluation for the intervention suggested increasing the percentages of member concentration within the LLC to positively affect adjustment, academic performance, and retention within the LLC membership (Gandhi, 1997). By the end of the period studied in the current investigation, participants were housed on seven different residence hall floors and comprised percentages of 14.3% to 73.3% (Median = 45.3%). In comparison, a random sampling of female residence hall floors during the midpoint of the intervention produced residence floor percentages of women studying math, science, or engineering ranging from 16.7% to 59.1% (Median = 24.7%). Although the percentages of member concentration within the LLC increased over time, LLCs in other studies have occupied entire or nearly entire residence hall floors (e.g., Madson et al., 1976; McKelfresh, 1980; Pascarella, Terenzini, & Blimling, 1994). The differences in percentages

of members on the LLC residence halls in the current study and LLCs studied in previous research could have contributed to the differences in outcome findings between the current study and earlier research. It appears promising that the current investigation did uncover several significant results in variables assessing adjustment, academic confidence, support, and retention, with a number of non-significant trends suggesting additional ways in which the LLC proved beneficial for its members. It is possible that additional differences will be discovered when the LLC population percentages are stable across time.

Additionally, the programming offered by the LLC in the current evaluation differed from the programming in some other LLCs. As indicated in the literature review on university living and learning environments, interventions with very different opportunities and goals have been combined in the literature. This has caused difficulty in distinguishing interventions and results that are comparable to the current investigation. Some interventions investigated in previous research studies have provided "in-house" academic classes and unique access to university professors who taught these "in-house" classes, while the LLC in the current evaluation focused on facilitating academic achievement and retention with social support and personal growth programming. Although some seminars were offered on academic topics and academic tutoring was offered, no classes were taught in the present LLC, differentiating it from other such interventions. Programming for the intervention may require a greater integration of academic and social opportunities if students are to benefit from an LLC experience as found in previous research (e.g., Magnarella, 1975; Pascarella, Terenzini, & Blimling, 1994).

Another limitation of the current study was the number of subjects available for the program evaluation. The sizes of the three cohorts in the present study were small; larger samples would provide greater stability and increased power to detect true differences among the cohorts and between participant groups. Additionally, differences might

become more prominent when the study participants are assessed at the completion of their collegiate careers. Graduation rates and final retention percentages would provide more complete information on the value of the LLC. At the same time, qualitative interviews may elicit suggestions from LLC members on methods to promote the intervention, better facilitate social support within the participants, and foster increased academic achievement and retention.

The lack of differences between the groups on academic performance highlights another limitation of the current investigation. Performance information accessed from university records included overall grade-point average only. An accurate analysis of academic performance in nontraditional courses of study is impossible without information on specific course grades. It is possible that the two participant groups would exhibit performance differences in nontraditional courses, which is of particular import and interest to researchers investigating intervention effects. Accessing individual course grades may enable a fair test of specific academic performance between the women who participated in the LLC and those who did not.

In general, results on the effectiveness of interventions such as the one under investigation are mixed. Although the study did not find the global effects hypothesized, several of the intervention's objectives were achieved. First, the LLC appeared to reach its primary goal of decreasing social isolation within its participants. The LLC members perceived greater social support among their floormates and seemed to gain some increased motivation to join other university organizations. Second, results suggested that the LLC partially achieved one of its secondary goals by increasing retention rates within nontraditional academic majors. Although significant differences did not emerge between the groups in all cohorts, women residing in the LLC achieved higher major retention rates than the non-participant group within each cohort and in each year of the study. An

additional secondary goal, increasing academic performance within nontraditional coursework, was not assessed and has been suggested as a direction for future research. Third, although the LLC did not achieve its tertiary objectives of significantly increasing university retention, overall academic performance, self-efficacy, and general adjustment, members of both participant groups achieved relatively high levels of each variable. It is encouraging that the respondents seemed quite satisfied with their acclimation into the university environment. It is possible that significant differences might emerge on these variables with a larger participant pool and with ongoing longitudinal research.

Conclusions

Factors predicting and leading to nontraditional career choice are complex and have been the subject of a growing body of research over the past thirty years. The current study evaluated one intervention hypothesized to assist women studying nontraditional majors. While the evaluation did not fully confirm the effectiveness of the LLC intervention, important conclusions and suggestions for future research have been reached. First, continuing a longitudinal research design will increase the size of the sample which may better locate differences among members of LLCs and members of a comparison group. Second, alternative LLC interventions might better determine the types of assistance universities can provide to aid women entering nontraditional fields.

Specific suggestions for the LLC in the current evaluation include continuing to increase concentrations of LLC members on the residence hall floors participating in the intervention, increasing academic programming with a focus on learning outcomes, incorporating "in-house" academic classes and facilitating greater access to professors, and continuing outcome based research. Determining the most helpful interventions may take repeated evaluations and creative assessments to achieve a better understanding of what

predicts nontraditional career interests, what supports nontraditional career choice, and what retains women in science, math, and engineering fields.

APPENDIX A

UNIVERSITY MAJORS ELIGIBLE FOR THE STUDY

Agricultural and Biosystems Engineering
Agricultural Engineering
Animal Ecology
Aerospace Engineering
Agricultural Biochemistry
Agricultural Microbiology
Agronomy
Animal Science
Biochemistry
Biophysics
Biomedical Engineering
Botany
Civil Engineering
Ceramic Engineering
Chemical Engineering
Chemistry
Computer Engineering
Computer Science
Construction Engineering
Dairy Science
Electrical Engineering
Entomology
Engineering Science
Forestry
Food Science
Fisheries and Wildlife Biology
Geological and Atmospheric Sciences
Genetics
Geology
Horticulture
Industrial Engineering
Industrial and Manufacturing Systems Engineering
Mathematics
Molecular, Cellular, and Developmental Biology
Mechanical Engineering
Metallurgical Engineering
Microbiology
Materials Science and Engineering
Meteorology
Neurosciences
Nutritional Science
Pre Agricultural Engineering
Pre Aerospace Engineering
Pre Civil Engineering
Pre Ceramic Engineering
Pre Chemical Engineering
Pre Construction Engineering
Pre Computer Engineering
Pre Electrical Engineering
Pre Engineering
Pre Engineering Science
Physics
Pre Industrial Engineering
Plant Pathology
Pre Mechanical Engineering
Pre Metallurgical Engineering
Pre Veterinary Medicine
Psychology
Statistics
Zoology

APPENDIX B

SAMPLE EVENT SCHEDULE FOR WOMEN IN THE LLC 1995-1996

August
20—Living Area Meeting, 5-7 pm, Friley Heritage Dining (Introduction to program, meet Dr. Epperson and other women in program!)
23—Computer Workshop, 5:30-7:30 pm, Friley Computer Lab
24—Computer Workshop, 5:30-7:30 pm, Friley Computer Lab
28—Computer Workshop, 5:30-7:30 pm, Friley Computer Lab
29—PWSE Annual Picnic, 5:30-7:30 pm, by Alumni Hall (Great food, prizes, music, fun)

September
5—Living Area Meeting, 5-7 pm, Friley Heritage Dining (AWIS & SWE reps. and a peer panel)
5—Collaborative Learning speaker: Catherine Hudsbeth, 7 pm, Friley Heritage Dining Room. Form study groups with women in your classes.
15—PWSE Mentoring Program meeting for Proteges, 12-1 pm, 290 Carver Hall, Free lunch provided.
19—Engineering Career Information Day in the Memorial Union!
20—Living Area Meeting, 5-7 pm, (Speaker on Women's Persistence in engineering majors)
20—Science Career Information Day in the Memorial Union!

October
3--Living Area Meeting, 5-7 pm, Friley Heritage Dining (MBTI Personality Inventory by the Student Counseling Service)
11—PWSE Archives Program, 12-1 pm, MU Gold Room
17-- Living Area Meeting, 5-7 pm, Friley Heritage Dining (Collaborative Learning)
23—Virtual Reality Lab Tour, 10 am-12 pm, 95E Basement of Black Engineering
26—Virtual Reality Lab Tour, 1-3 pm, 95E Basement of Black Engineering
31—Living Area Meeting

November
8—PWSE Scholarship & Internship Workshop, 4-5 pm, 114 Marston
14—Living Area Meeting, 5-7 pm, Friley Heritage Dining (Sexual Harassment)
28—Living Area Meeting
29—PWSE Holiday Party, 5:30-7:30 pm, MU Cardinal Room (Great food and a White Elephant Gift Exchange)

January
13—Ice skating at ISU Hockey Rink, 3 pm
15—Cocoa party in Old Jones Den, 8 pm
28—Resume Writing Workshop, Chessman Lounge, 5:30 pm (Dinner)

February
1—Hutton/Henderson Open House, 9-10 pm
8—Rowe Open House, 9-10 pm
12—Interview Tips Workshop, Chessman Lounge, 6 pm (Dinner)
14—Secret Sisters Valentine Party, Old Jones Den, 9 pm
15—Sadler Open House, 9-10 pm

March
4—Faculty Dinner, Chessman Lounge, 6 pm (Dinner)

April
25—Test Anxiety/Stress Relief Workshop, Old Jones Den, 6 pm (Dinner)
27—Barbeque/Camping at the Ledges State Park, 4 pm

On-going Programs

Test File
Peer Study Groups
Executive Board Weekly Meetings
Name/T-shirt Committee
Brochure/advertising for Fall 1996
Fall 1996 Plans
Big Sister Program

APPENDIX C

SAMPLE LETTER OF INVITATION TO THE LLC

May 2, 1995

Dear Student,

We at the Program for Women in Science and Engineering are excited about a new housing option from the ISU Residence Halls that places twenty women in the Women in Science and Engineering Living Area as part of a pilot learning community. This learning community will be based on common academic interests and pursuits of freshman women majoring in science and engineering.

We plan to coordinate special programming for students living in this housing area. These programs will include workshops on Internet explorations, panel discussions by upper class undergraduate women on strategies for academic success at ISU, juggling academics and rest of your life, and seminars on relevant issues like enhancing your chances at winning scholarships. We will also provide opportunities for you to be matched up with mentors who will meet with you on a one-on-one basis. Students will have the opportunity to work with study groups. And, most of all, we will work with you to plan future events to enhance your academic and social experiences during your first year at ISU.

Since space in this housing unit is limited to 20 and will be allocated by the Department of Residence on a first come first served basis, I encourage you to respond with your application as soon as possible.

Please come visit our office in 210 Lab of Mechanics and sign up to be on our mailing list for campus programs regardless of where you choose to live. Our purpose is to help you live up to your potential as a woman in science and engineering at Iowa State University and to have you serve as an inspiration to younger girls. Through PWSE you will have the opportunity to meet other women scientists and engineers and to serve as a role model for girls who may some day choose to follow in your footsteps.

If you have questions about the activities that will be offered in the Women in Science and Engineering Living Area, please call me at 515-294-4317. We are looking forward to working with you next Fall.

Sincerely,

Krishna Athreya
On-campus Coordinator

APPENDIX D

iNFORMED CONSENT AND ACADEMIC RECORD RELEASE FORM

CONSENT FORM

Description of Study

As a participant in this study, you will be asked to complete a questionnaire about your background and your attitudes about women in science and engineering. Additionally, you will be interviewed during the year about your adjustment to classes, the dorm floor, and life at Iowa State University. These interviews will be semi-structured and will not ask sensitive or personal questions.

Conditions of Participation

Your participation in this study is voluntary, and you are free to withdraw your consent and discontinue participation in the study at any time. The information you provide on the written questionnaire and in the personal interviews will be safeguarded and remain confidential. Only group data will be reported and analyzed. No individual responses will be reported.

Consent to Participate

Your signature below indicates that you have read and understood this form, and you freely and voluntarily consent to participate in this study under the conditions outlined.

_____ _____

Signature of Participant Date

SCORE RELEASE CONSENT FORM

We would like to obtain/confirm your grades from the registrar and your ACT and/or SAT score directly with American College Testing and Educational Testing Service, respectively. If you would permit this, please check the appropriate box and sign below. These scores are an important part of our data set. Please remember that your name will be removed from the scores as soon as they are received, and all information in this study will be confidential.

___ Yes, you have permission to obtain/confirm my ACT and/or SAT scores directly with the test publishers.

___ No, you do not have permission to obtain/confirm my ACT and/or SAT scores directly with the test publishers.

Student Signature_____

APPENDIX E

SAMPLE FOLLOW-UP QUESTIONNAIRE COVER LETTER

IOWA STATE UNIVERSITY
DEPARTMENT OF PSYCHOLOGY
W206 Lagomarcino, Ames, Iowa 50011-3180
(515) 294-2047

Douglas L. Epperson, Ph.D.
Christina M. O. Gandhi
Margie M. Nauta
Keri B. Bassman

April 1996

Dear Science, Math, or Engineering Student:

Last semester you were asked to complete a survey similar to the one you'll find enclosed. We are investigating factors that may influence women's decisions about whether or not to pursue college majors and occupations in science, math, or engineering. The information you provided us last fall and the information you'll provide by completing this questionnaire will add a valuable component to our knowledge of how women make educational and occupational decisions and will help guide future programs designed to meet female students' needs.

Last fall when we initially contacted you we told you that after completing this final questionnaire your name would be entered into a drawing for three $75 gift certificates at the University Book Store. The number of students receiving this opportunity is small, so your chances at winning are good! Please return your questionnaire by Friday, April 19, so that your name can be included in the drawing to be held at the end of the month.

Thank you for your willingness to assist us in this research. Please feel free to contact us if you have any questions.

Sincerely,

Douglas L. Epperson

Christina M. O. Gandhi

Margie M. Nauta

Keri B. Bassman

APPENDIX F

SAMPLE FOLLOW-UP POSTCARD AND LETTER

Dear _____,

Just a reminder...

About 10 days ago you received a questionnaire similar to one that you completed last fall semester asking you about factors that may influence women's decisions about whether or not to pursue college majors and occupations in science, math, or engineering. Regardless of whether you have changed majors, if you complete this final questionnaire your name will be entered into a drawing for **three $75 gift certificates at the University Book Store.** The number of students receiving this opportunity is small, so your chances at winning are good! If you have already completed and returned the questionnaire, we thank you. If you have not, please return your questionnaire within the next week so that your name can be included in the drawing to be held at the end of the month. Your input is critical to the success of this study.

If you have any questions or need another copy of the questionnaire, please feel free to contact us. Thank you!

Douglas L. Epperson
294-2047

Christina M. O. Gandhi
294-8759

IOWA STATE UNIVERSITY
DEPARTMENT OF PSYCHOLOGY
W206 Lagomarcino, Ames, Iowa 50011-3180

Douglas L. Epperson, Ph.D.
Voice: (515) 294-2047
FAX: (515) 294-6424
E-mail: dle@iastate.edu

April 25, 1996

Dear Science, Math, or Engineering Student:

About two weeks ago you received a survey from us and were asked to complete and return it. The responses of students like yourself will help us identify and better understand factors that may influence women's decisions about whether on not to enroll and persist in a science, math, or engineering major.

Another copy of the survey is enclosed for you convenience in case you have misplaced the original copy. We recognize that this is a busy time of the year for you, and we greatly appreciate your efforts at completing this survey. Your input is critical to the success of this study. **Regardless of whether or not your have changed majors, we ask you to complete this survey**. As you were told last fall, if you complete this final questionnaire, your name will be entered into a drawing for **THREE $75 gift certificates at the University Book Store**. The number of students receiving this opportunity is small, so your chances of winning are good.

Thank you for your willingness to assist us in this research. Please feel free to contact us if you have any questions.

Sincerely,

Douglas L. Epperson, Ph.D.

Christina M. O. Gandhi, B.S.

Margie M. Nauta, M.S.

Keri B. Bassman

APPENDIX G

SAMPLE COVER LETTER FOR NONPARTICIPANT BACKGROUND QUESTIONNAIRE

IOWA STATE UNIVERSITY
DEPARTMENT OF PSYCHOLOGY
W206 Lagomarcino, Ames, Iowa 50011-3180
(515) 294-2047

Douglas L. Epperson, Ph.D.
Christina M. O. Gandhi
Margie M. Nauta
Keri B. Bassman

November 3, 1995

Dear Science or Engineering Student:

Thank you so much for agreeing to complete the enclosed background questionnaire. The questionnaire should only take 30 minutes to complete. As you know from our earlier telephone conversation, we are collecting information about factors that may influence the choices young women make about whether or not they will pursue college majors and occupations in science or engineering. The information you provide will add a valuable component to our knowledge of how young women make educational and occupational decisions and will help guide future programs designed to meet female students' needs. We also want to remind you that returning your completed questionnaire and completing a second brief questionnaire toward the end of spring semester will enter your name in a drawing for three $75 gift certificates.

You may also recall that we would like to obtain your ACT/SAT scores and information about your grades during your undergraduate years at Iowa State University from the Registrar's Office. This information will enable us to follow your performance at ISU and to see if pre-college ability measures predict performance or persistence in science and engineering majors. Please remember that your name will be removed from scores or grades as soon as they are received to preserve your anonymity in our database. You also may revoke permission in writing at any time; otherwise, your permission will expire six years from the date that it was granted.

Again, thank you for your willingness to assist us in this research. Please sign the two attached consent forms and return them with your completed questionnaire in the enclosed postage-paid envelope as soon as possible. Feel free to call us if you have any questions

Sincerely,

Douglas L. Epperson Christina M. O. Gandhi Margie M. Nauta Keri B. Bassman

APPENDIX H

SAMPLE REMINDER POSTCARD FOR BACKGROUND QUESTIONNAIRE

Dear _____,

Just a reminder...

About 10 days ago you received a questionnaire asking you about factors that may influence women's decisions about whether or not to pursue college majors and occupations in science, math, or engineering. Regardless of whether you have changed majors, by completing this questionnaire and one similar to it next semester your name will be entered into a drawing for **three $75 gift certificates at the University Book Store.** The number of students receiving this opportunity is small, so your chances at winning are good! If you have already completed and returned the questionnaire, we thank you. If you have not, please return your questionnaire within the next week so that your name can be included in the drawing to be held next semester. Your input is critical to the success of this study.

If you have any questions or need another copy of the questionnaire, please feel free to contact us. Thank you!

Douglas L. Epperson
294-2047

Christina M. O. Gandhi
294-8759

APPENDIX I

DEMOGRAPHIC QUESTIONS

General Directions: Please fill in the blanks and/or circle the appropriate response choices for each item.

What is your age? _____ What is your major at ISU? _____

Do you live in a residence hall? Yes _____ No _____

If yes, what is the name of your residence hall and floor_____

During middle school or high school, did you attend any of the career conferences for young women in science and engineering sponsored by Iowa State University? Yes_____ No_____

Which of the following describes your race (circle one)?

1. European American/Caucasian
2. Hispanic American
3. African American
4. Asian American
5. Native American/American Indian
6. Other (specify)_____

Please write the number of siblings you have in each of the following categories:

Older sisters_____ Younger sisters_____ Twin sisters_____
Older brothers _____ Younger brothers _____ Twin brothers_____

In what state did you attend high school? _____

What is the name of the town/city in which you lived or that was closest to you during your high school years? _____

Where did you live relative to the town/city (circle one)?

1. in the town/city
2. in a suburb of the town/city
3. in the country or on a farm outside of town

What was the approximate size of your graduating class in high school? _____

What type of high school did you attend (circle one)? 1. Co-educational 2. All female

Was your high school public or private (circle one)? 1. Public 2. Private

How well do you think your high school prepared you for college (circle one):

very poorly poorly adequately well very well

What is the highest level of education you anticipate completing (circle one)?

1. Bachelor's degree
2. Master's degree
3. Doctoral degree
4. Other (specify)_____

How many of your acquaintances from high school are:

enrolled at ISU this year? _____
majoring in science, mathematics, or engineering? _____
living in the same residence hall house? _____

Check any of the following organizations that you intend to join or have already joined.

Society of Women in Engineering _____
Association of Women in Science _____
A sorority _____

What is your parents' marital status (circle one)?

1. Married
2. Never married
3. Separated
4. Divorced
5. Widowed
6. Other (specify)_____

Please place **one** "X" in **each** column below to indicate the **highest** level of education attained by each of the relatives listed. If you are uncertain about the educational history of one of the relatives, make your best estimate.

	Father	Mother	Maternal Grand-mother	Paternal Grand-mother	Aunt Closest to You
1. Less than high school	_____	_____	_____	_____	_____
2. High school	_____	_____	_____	_____	_____
3. Technical or Vocational school	_____	_____	_____	_____	_____
4. Bachelor's degree	_____	_____	_____	_____	_____
5. Master's degree	_____	_____	_____	_____	_____
6. Doctoral degree	_____	_____	_____	_____	_____

Please place **one** "X" on the appropriate line in **each** column below to indicate the **general** or **usual** employment status of each of your parents during your developmental years.

	Father	Mother
1. Never employed	_____	_____
2. Employed part-time	_____	_____
3. Employed full-time	_____	_____

What is your father's occupation (if employed)? _____

What is your mother's occupation (if employed)? _____

At what age do you plan to complete your college education? _____

Do you plan to become married? 1. Yes 2. No

If yes, at what age do you anticipate getting married? _____

Do you plan to have children? 1. Yes 2. No

If yes, at what age do you anticipate having children? _____

In the space provided below, please list all the **high school math and science classes** that you **completed**, along with the grade you received in the class.

Ninth Grade

Class Title	Grade

Tenth Grade

Eleventh Grade

Class Title	Grade

Twelfth Grade

In the space provided below, please list all the courses in which your are enrolled this semester.

Course number	Course title

If you have taken any of the following examinations and know your scores, please provide the information requested below:

ACT Scores

_____ English
_____ Math
_____ Reading
_____ Science Reasoning
_____ Composite

SAT Scores

_____ Verbal
_____ Quantitative

APPENDIX J

ROLE MODELS

How many people do you know in each of the following categories? Please write your answers in the spaces provided.

Female science teachers_____ Female math teachers_____ Female scientists_____ Female engineers_____

How many female math and science teachers did you have in each of the following grades? Please write the number in the space provided.

Female Math Teachers

Grade 6 ____ Grade 7 ____ Grade 8 ____ Grade 9 ____ Grade 10 ____ Grade 11 ____ Grade 12 ____

Female Science Teachers

Grade 6 ____ Grade 7 ____ Grade 8 ____ Grade 9 ____ Grade 10 ____ Grade 11 ____ Grade 12 ____

APPENDIX K

ROLE MODELS INFLUENCE SCALE (RMIS)

AND ROLE MODELS INFLUENCE SCALE ON NONTRADITIONAL CAREER CHOICE

Please rate the direction and degree of influence each of these people has on your life **in general**. Someone would have a **"negative influence"** on your life in general if you think that your life is in some way worse as a result of knowing that person. Someone would have a **"positive influence"** on your life in general if you think that your life is in some way better as a result of knowing that person. Someone would have a **"neutral influence"** on your life in general if you think that your life is no better and no worse as a result of knowing that person. Please circle "N/A" for items that do not apply to you. Do not spend too much time on any one item. We are most interested in you immediate reaction.

	negative influence			neutral influence		positive influence		not applicable
1. Mother	-3	-2	-1	0	1	2	3	N/A
2. Father	-3	-2	-1	0	1	2	3	N/A
3. Sister(s)	-3	-2	-1	0	1	2	3	N/A
4. Brother(s)	-3	-2	-1	0	1	2	3	N/A
5. Male Teacher(s)	-3	-2	-1	0	1	2	3	N/A
6. Female Teacher(s)	-3	-2	-1	0	1	2	3	N/A
7. Male Friend(s)	-3	-2	-1	0	1	2	3	N/A
8. Female Friend(s)	-3	-2	-1	0	1	2	3	N/A
9. Male Adult(s) (e.g., uncle, grandfather, family friend)	-3	-2	-1	0	1	2	3	N/A
10. Female Adult(s) (e.g., aunt, grandmother, family friend)	-3	-2	-1	0	1	2	3	N/A
11. Man (men) employed in science or mathematics	-3	-2	-1	0	1	2	3	N/A
12. Woman (women) employed in science or mathematics	-3	-2	-1	0	1	2	3	N/A
13. Other (Please specify _____)	-3	-2	-1	0	1	2	3	N/A

To what degree have each of the following people or factors influenced your decision about whether or not to continue in science, mathematics, or engineering? A person or factor would have a "negative influence" if that person or factor discourages you in some way from pursuing a college major in science, mathematics, or engineering. A person or factor would have a "positive influence" if that person or factor encourages you in some way to pursue a college major in science, mathematics, or engineering. A person or factor would have a "neutral influence" if that person or factor neither encourages nor discourages you from pursuing a college major in science, mathematics, or engineering. If an item does not seem to apply to you, please circle "N/A". Do not spend to much time on any one item. We are most interested in your immediate reaction.

	negative influence			neutral influence			positive influence	not applicable
1. Mother	-3	-2	-1	0	1	2	3	N/A
2. Father	-3	-2	-1	0	1	2	3	N/A
3. Sister(s)	-3	-2	-1	0	1	2	3	N/A
4. Brother(s)	-3	-2	-1	0	1	2	3	N/A
5. Male Teacher(s)	-3	-2	-1	0	1	2	3	N/A
6. Female Teacher(s)	-3	-2	-1	0	1	2	3	N/A
7. Male Friend(s)	-3	-2	-1	0	1	2	3	N/A
8. Female Friend(s)	-3	-2	-1	0	1	2	3	N/A
9. Male Adult(s) (e.g., uncle, grandfather, family friend)	-3	-2	-1	0	1	2	3	N/A
10. Female Adult(s) (e.g., aunt, grandmother, family friend)	-3	-2	-1	0	1	2	3	N/A
11. Man (men) employed in science or mathematics	-3	-2	-1	0	1	2	3	N/A
12. Woman (women) employed in science or mathematics	-3	-2	-1	0	1	2	3	N/A
13. Salary of jobs	-3	-2	-1	0	1	2	3	N/A
14. Enjoyment of subject matter	-3	-2	-1	0	1	2	3	N/A
15. Anticipated enjoyment of career tasks	-3	-2	-1	0	1	2	3	N/A
16. Success at courses	-3	-2	-1	0	1	2	3	N/A
17. Contribution to society	-3	-2	-1	0	1	2	3	N/A
18. Opportunities for advancement	-3	-2	-1	0	1	2	3	N/A
19. Other (Please specify _____)	-3	-2	-1	0	1	2	3	N/A

APPENDIX L

MATHEMATICS SELF-EFFICACY SCALE (MSE)

AND SCIENCE-RELATED SELF-EFFICACY SCALE

Please rate your confidence in your ability to **complete the following courses with a grade of "B" or better.** Use the 10-point scale below, with higher numbers representing increasingly greater levels of confidence. Do not spend too much time on any one item. We are most interested in your immediate reaction.

No confidence at all 1 2 3 4 5 6 7 8 9 10 **Complete confidence**

	No confidence at all									Complete confidence
1. Advanced Calculus	1	2	3	4	5	6	7	8	9	10
2. Computer Science	1	2	3	4	5	6	7	8	9	10
3. Business Administration	1	2	3	4	5	6	7	8	9	10
4. Biochemistry	1	2	3	4	5	6	7	8	9	10
5. Calculus	1	2	3	4	5	6	7	8	9	10
6. Zoology	1	2	3	4	5	6	7	8	9	10
7. Accounting	1	2	3	4	5	6	7	8	9	10
8. Geometry	1	2	3	4	5	6	7	8	9	10
9. Algebra I	1	2	3	4	5	6	7	8	9	10
10. Algebra II	1	2	3	4	5	6	7	8	9	10
11. Philosophy	1	2	3	4	5	6	7	8	9	10
12. College Algebra	1	2	3	4	5	6	7	8	9	10
13. Statistics	1	2	3	4	5	6	7	8	9	10
14. Physiology	1	2	3	4	5	6	7	8	9	10
15. Trigonometry	1	2	3	4	5	6	7	8	9	10
16. Economics	1	2	3	4	5	6	7	8	9	10
17. Human Anatomy	1	2	3	4	5	6	7	8	9	10
18. Botany	1	2	3	4	5	6	7	8	9	10
19. Environmental Studies	1	2	3	4	5	6	7	8	9	10
20. Engineering	1	2	3	4	5	6	7	8	9	10
21. Genetics	1	2	3	4	5	6	7	8	9	10
22. Physics	1	2	3	4	5	6	7	8	9	10
23. Chemistry	1	2	3	4	5	6	7	8	9	10

APPENDIX M

RETENTION QUESTIONS AND EDUCATIONAL GOALS

General Directions: Please fill in the blanks and/or circle the appropriate response choices for each item.

- Do you live in a residence hall? Yes _____ No _____

  If yes,

  what is the name of your residence hall and floor_____

  How easy or hard has it been to get to know others on your floor (circle appropriate number)?
  Easy 1 2 3 4 5 6 7 8 9 10 Hard

  How much in common do you have with others living on your floor (circle appropriate number)?
  Little 1 2 3 4 5 6 7 8 9 10 Much

  Would you live on the same residence hall floor again? Yes _____ No _____

- How much support do you feel you've received from your friends and family in pursuing a major in science/math/engineering?

  Little 1 2 3 4 5 6 7 8 9 10 Much

- How well do you think your high school prepared you for college (circle one):

  very poorly poorly adequately well very well

- What is the highest level of education you anticipate completing (circle one)?

  1. Bachelor's degree 2. Master's degree 3. Doctoral degree 4. Other (specify)_____

- Have classes at Iowa State been easier or harder than you expected?

  Much easier 1 2 3 4 5 6 7 8 9 10 Much harder

- At this point in your education, what grades would you define as satisfactory for you? (circle one)

  1. An A average
  2. An A- average
  3. A B+ average
  4. A B average
  5. A B- average
  6. A C+ average
  7. A C average
  8. Less than a C average

- What percentage of your instructors in science, mathematics, and engineering classes have been women?
  _____

- Check any of the following organizations that you intend to join or have already joined.

  Society of Women in Engineering _____ A sorority _____
  Association of Women in Science _____ Honor's Program _____

What is your major at ISU? _____

- Have you changed your major since entering Iowa State? Yes ____ No _____

If you have not changed your major,

How certain are you that you will stay in your current major?

Little 1 2 3 4 5 6 7 8 9 10 Very

If you are thinking of changing majors, which other specific majors are you considering?

APPENDIX N

CONFIDENCE OF ACADEMIC ACHIEVEMENT

Please indicate how confident you feel in your ability to do each of the following things. Use the 10-point scale provided.

No confidence at all 1 2 3 4 5 6 7 8 9 10 **Complete confidence**

	No confidence at all									Complete confidence
1. Complete your degree	1	2	3	4	5	6	7	8	9	10
2. Complete your degree on time (i.e., 4-5 years)	1	2	3	4	5	6	7	8	9	10
3. Achieve a cumulative GPA of 3.0 by graduation	1	2	3	4	5	6	7	8	9	10
4. Understand the material in your classes	1	2	3	4	5	6	7	8	9	10
5. Work closely on a research team with faculty members or graduate students	1	2	3	4	5	6	7	8	9	10
6. Get a good job in your field with your degree	1	2	3	4	5	6	7	8	9	10

ITEMS ELIMINATED WITH COHORTS 2 AND 3:

7. Complete your degree at Iowa State University	1	2	3	4	5	6	7	8	9	10
8. Pay for college	1	2	3	4	5	6	7	8	9	10
9. Know degree requirements	1	2	3	4	5	6	7	8	9	10
10. Maintain a balance between school and personal lives	1	2	3	4	5	6	7	8	9	10
11. Handle course work	1	2	3	4	5	6	7	8	9	10
12. Handle the stress related to college	1	2	3	4	5	6	7	8	9	10
13. Do well in college	1	2	3	4	5	6	7	8	9	10
14. Do well in science, math, or engineering courses	1	2	3	4	5	6	7	8	9	10
15. Do well with the math for science/engineering courses	1	2	3	4	5	6	7	8	9	10
16. Achieve success in your career	1	2	3	4	5	6	7	8	9	10
17. Combine a science, math, or engineering career with having a happy marriage and family	1	2	3	4	5	6	7	8	9	10
18. Question the opinions of others in class	1	2	3	4	5	6	7	8	9	10
19. Meet people and make friends	1	2	3	4	5	6	7	8	9	10
20. Socialize with other students who are interested in science, math, or engineering	1	2	3	4	5	6	7	8	9	10

APPENDIX O

CONFIDENCE OF RECEIVING SUPPORT WITHIN SCIENCE AND ENGINEERING FIELDS

Using the 10-point scale below, please indicate how confident you are that you will experience the following actions?

	No confidence at all									Complete confidence
1. Being encouraged by faculty to pursue a degree in science, math, or engineering	1	2	3	4	5	6	7	8	9	10
2. Receiving positive feedback from your science/ engineering/math instructors	1	2	3	4	5	6	7	8	9	10
3. Being accepted by other students in your classes	1	2	3	4	5	6	7	8	9	10
4. Teachers caring about how you are doing	1	2	3	4	5	6	7	8	9	10
5. Being encouraged by friends to pursue a degree in engineering	1	2	3	4	5	6	7	8	9	10
6. Being encouraged by family members to think about a degree in engineering/science/math	1	2	3	4	5	6	7	8	9	10
7. Receiving help from other students in your field	1	2	3	4	5	6	7	8	9	10

ITEMS ADDED WITH COHORTS 2 AND 3:

8. Expect to receive more encouragement from faculty with progression through the program	1	2	3	4	5	6	7	8	9	10
9. Expect to receive more encouragement from students with progression through the program	1	2	3	4	5	6	7	8	9	10

APPENDIX P

SELF CONFIDENCE IN ACADEMIC SKILLS

Compared to other students entering college in the science, math, or engineering, please rate yourself on each of the following traits. We want the most accurate estimate of how you see yourself. (Circle one answer for each item)

	Lowest 10%	Below Average	Average	Above Average	Highest 10%
1. Overall academic ability	1	2	3	4	5
2. Analytical and problem-solving skills	1	2	3	4	5
3. Ability to think critically	1	2	3	4	5
4. English writing skills	1	2	3	4	5
5. Mathematical abilities	1	2	3	4	5
6. Computer skills	1	2	3	4	5
7. Ability to work independently	1	2	3	4	5
8. Scientific reasoning	1	2	3	4	5
9. Ability to work cooperatively	1	2	3	4	5

ITEMS EXCLUDED WITH COHORTS 2 AND 3:

1. Knowledge of field or discipline	1	2	3	4	5
2. Language skills other than English	1	2	3	4	5
3. Drive to achieve	1	2	3	4	5
4. Leadership abilities	1	2	3	4	5
5. Interpersonal skills	1	2	3	4	5
6. Competitiveness	1	2	3	4	5
7. Oral communication skills in English	1	2	3	4	5
8. Self-confidence (intellectual)	1	2	3	4	5
9. Self-confidence (social)	1	2	3	4	5
10. Listening ability	1	2	3	4	5

APPENDIX Q

PERSONAL ADJUSTMENT

Please indicate your degree of agreement with each of the following statements.

Disagree 1 2 3 4 5 **Agree**

		Disagree				Agree
1.	I am comfortable socializing with other students who are interested in science, math, or engineering.	1	2	3	4	5
2.	My adjustment to college has been difficult	1	2	3	4	5
3.	Overall, my physical health has been good this year.	1	2	3	4	5
4.	I have had significant problems with depression, stress/anxiety, and/or loneliness..	1	2	3	4	5

ITEMS ADDED WITH COHORTS 2 AND 3:

5.	College has been very stressful for me this year.	1	2	3	4	5
6.	There is at least one person on campus with whom I can talk freely.	1	2	3	4	5
7.	I have been lonely quite often this year.	1	2	3	4	5
8.	I have made many friends this year.	1	2	3	4	5
9.	I have handled stress well this year.	1	2	3	4	5
10.	I have felt depressed a lot this year.	1	2	3	4	5
11.	Overall, I'm glad I came to Iowa State.	1	2	3	4	5

APPENDIX R

LLC PARTICIPANT QUESTIONNAIRE

Using the 10-point scale below, to what degree did each of the following influence your decision to apply to participate in the residence hall program? (Circle all that apply)

Did not influence my decision at all 1 2 3 4 5 6 7 8 9 10 **Greatly influenced my decision**

		Did not influence my decision at all									Greatly influenced my decision
1.	Wanted to be part of a smaller group on campus	1	2	3	4	5	6	7	8	9	10
2.	Wanted to make friends with other students in my field	1	2	3	4	5	6	7	8	9	10
3.	Wanted to live in a specific residence hall	1	2	3	4	5	6	7	8	9	10
4.	Knew someone else in the program	1	2	3	4	5	6	7	8	9	10
5.	Was encouraged to participate in program by my advisor	1	2	3	4	5	6	7	8	9	10
6.	Wanted the academic enrichment	1	2	3	4	5	6	7	8	9	10
7.	Having access to supportive study groups	1	2	3	4	5	6	7	8	9	10
8.	Ability to participate in special workshops in my major area	1	2	3	4	5	6	7	8	9	10
9.	Informal help or tutoring with difficult subjects	1	2	3	4	5	6	7	8	9	10
10.	More likely to get advice and information about possible careers in my field	1	2	3	4	5	6	7	8	9	10

REFERENCES

Adams, D. V. (1974). Residential learning opportunities. In D. A. DeCoster and P. Mable (Eds.), Student development and education in college residence halls (pp. 87-94). Washington, D.C.: American College Personnel Association.

Adelman, C. (1994). Lessons of a generation. San Francisco: Jossey-Bass, Inc.

American Testing Program. (1991). Supplement to the preliminary technical manual for the enhanced ACT assessment. Iowa City, IA: Author.

Anderson, V. (1995). Identifying special advising needs of women engineering students. Journal of College Student Development, 36(4), 322-329.

Arminio, J. (1994). Living-learning centers: Offering college students an enhanced college experience. The Journal of College and University Student Housing, 24(1), 12-17.

Arnold, K. D. (1993). Undergraduate aspirations and career outcomes of academically talented women: A discriminant analysis. Roeper Review, 15(3), 169-175.

Astin, A. W. (1977). Four critical years. San Francisco: Jossey-Bass.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. Psychological Review, 84(2), 191-215.

Bandura, A. (1986). Social foundations of thought and action. Englewood Cliffs, NJ: Prentice-Hall.

Barnes, S. F. (1977). An evaluation of the 1971-1972 live and learn program and its effect on residence hall social ecology, academic achievement, interpersonal growth, and study and communication skills development of University of Oregon freshmen (Doctoral dissertation, University of Oregon, 1977). Dissertation Abstracts International, 38(3), 1242A-1243A.

Basow, S. A., & Howe, D. G. (1980). Role-model influence: Effects of sex and sex-role attitude in college students. Psychology of Women Quarterly, 4, 558-572.

Benbow, C. P., & Arjmand, O. (1990). Predictors of high academic achievement in mathematics and science by mathematically talented students: A longitudinal study. Journal of Educational Psychology, 82(3), 430-441.

Benbow, C. P., & Stanley, J. C. (1980). Sex differences in mathematical ability: Fact or artifact? Science, 210, 1262-1264.

Betz, N. E. (1989). Implications of the null environment hypothesis for women's career development and for counseling psychology. The Counseling Psychologist, 17(1), 136-144.

Betz, N. E. (1994). Career counseling for women in the sciences and engineering. In W. B. Walsh and S. H. Osipow, (Eds.), Career counseling for women (pp. 237-261). Hillsdale, N.J.: Lawrence Erlbaum Associates.

Betz, N. (1997). What stops women and minorities from choosing and completing majors in science and engineering? In D. Johnson (Ed.), Minorities and girls in school (pp.105-140). Thousand Oaks, CA: Sage Publications.

Betz, N. E., & Fitzgerald, L. F. (1987). The career psychology of women. New York: Academic Press, Inc.

Betz, N. E., & Hackett, G. (1981). The relationship of career-related self-efficacy expectations to perceived career options in college women and men. Journal of Counseling Psychology, 28(5), 399-410.

Betz, N. E., & Hackett, G. (1983). The relationship of mathematics self-efficacy expectations to the selection of science-based college majors. Journal of Vocational Behavior, 23, 329-345.

Bickart, T. A. (1991). Gateway to pluralism: Recruitment and retention. Engineering Education, 81(4), 419-424.

Blimling, G. S. (1993). The influence of college residence halls on students. In J. Smart (Ed.), Higher education: Handbook of theory and research (pp. 248-307). New York: Agathon Press.

Blimling, G. S., & Hample, D. (1979). Structuring the peer environment in residence halls to increase academic performance in average-ability students. Journal of College Student Personnel, 20(4), 310-316.

Borgen, F. H., & Seling, M. (1978). Expressed and inventoried interests revisited: Perspicacity in the person. Journal of Counseling Psychology, 25(6), 536-543.

Borget, M. M., & Gilroy, F. D. (1994). Interests and self-efficacy as predictors of mathematics/science-based career choice. Psychological Reports, 75, 753-754.

Brown, R. D. (1986). Manipulation of the environmental press in a college residence hall. Personnel and Guidance Journal, 46, 555-560.

Brown, R. P., & Josephs, R. A. (1999). A burden of proof: Stereotype relevance and gender differences in math performance. Journal of Personality and Social Psychology, 76(2), 246-257.

Brown, S. D., Lent, R. W., & Larkin, K. C. (1989). Self-efficacy as a moderator of scholastic aptitude—academic performance relationships. Journal of Vocational Behavior, 35, 64-75.

Card, J. J., Steel, L., & Abeles, R. P. (1980). Sex differences in realization of individual potential for achievement. Journal of Vocational Behavior, 17, 1-21.

Casserly, P. L. (1979.) Helping able young women take math and science seriously in school. In N. Colangelo & R. T. Zaffrann (Eds.), New voices in counseling the gifted (pp. 346-369). Dubuque, IA: Kendall/Hunt.

Centra, J. A. (1968). Student perceptions of residence hall environments: Living-learning vs. conventional units. The Journal of College Personnel, 4, 266-272.

Chapple, J. D. (1984). Freshman housing assignments: A road to student retention. The Journal of College Admissions, 102, 27-28.

Chatterjee, J. & McCarrey M. (1989). Sex role attitudes of self and those inferred of peers, performance, and career opportunities as reported by women in nontraditional vs. traditional training programs. Sex Roles, 21(9-10), 653-669.

Chipman, S. F., Krantz, D. H., & Silver, R. (1992). Mathematics anxiety and science careers among able college women. Psychological Science, 3(5), 292-295.

Collis, B. (1985). Psychosocial implications of sex differences in attitudes toward computers: Results of a survey. International Journal of Women's Studies, 8(3), 207-213.

Cramer, J., & Oshima, T. C. (1992). Do gifted females attribute their math performance differently than other students? Journal for the Education of the Gifted, 16(1), 18-35.

Crew, J. L., & Giblette, J. F. (1965). Academic performance of freshman males as a function of residence hall housing. The Journal of College Student Personnel, 6, 167-170.

Daniels, J. Z. (1988). Women in engineering: A program administrator's perspective. Engineering Education, 78, 766-768.

Davis, B. G., & Humphreys, S. (1985). Evaluating intervention programs. New York City: Teachers College Press.

DeCoster, D. A. (1966). Housing assignments for high ability students. Journal of College Student Personnel, 7, 19-22.

DeCoster, D. A. (1968). Effects of homogeneous housing assignments for high ability students. The Journal of College Personnel, 9, 75-78.

Deno, C. M. (1993). Women in engineering conference proceedings: Increasing enrollment and retention. Washington, DC: Women in Engineering Program Advocates Network.

Dick, T. P., & Rallis, S. F. (1991). Factors and influences on high school students' career choices. Journal for Research in Mathematics Education, 22(4), 281-292.

Douce, L. A., & Hansen, J. C. (1990). Willingness to take risks and college women's career choice. Journal of Vocational Behavior, 36, 258-273.

Duncan, C. M., & Stoner, K. L. (1976). The academic achievement of resident living in a scholar residence hall. The Journal of College and University Student Housing, 6(2), 7-9.

Eccles, J. S. (1987). Gender roles and women's achievement-related decisions. Psychology of Women Quarterly, 11, 135-172.

Elton, C. F., & Bate, W. S. (1966). The effect of housing policy on grade-point average. The Journal of College Student Personnel, 7, 73-77.

Fassinger, R. E. (1990). Causal models of career choice in two samples of college women. Journal of Vocational Behavior, 36(2), 225-248.

Felver, J. E., Jr. (1983). A longitudinal study of the effects of living/learning programs (Doctoral dissertation, Northern Illinois University, 1983). Dissertation Abstracts International, 44(12), 3607A-3608A.

Fitzpatrick, J. L., & Silverman, T. (1989). Women's selection of careers in engineering: Do traditional-nontraditional differences still exist? Journal of Vocational Behavior, 34, 266-278.

Freeman, J. (1979). How to discriminate against women without really trying. In J. Freeman (Ed.), Women: A feminist perspective (2nd ed., pp. 194-208). Palo Alto, CA: Mayfield.

Gandhi, C. M. O. (1997). The women in science and engineering living option at Iowa State University: A program evaluation. Unpublished master's thesis, Iowa State University, Ames, IA.

Geppert, L. (1995, May). The uphill struggle – No rose garden for women in engineering. IEEE Spectrum, 40-50.

Giurleo, S. (1997). Persisters and career changers in technical careers. In H. S. Farmer and Associates (Eds.), Diversity and women's career development (pp. 81-94). Thousand Oaks, CA: Sage Publications.

Golden, R. D., & Smith, D. A. (1983). Potential benefits of academic units in the college residence hall: An issue revisited. The Journal of College and University Student Housing, 13(2), 8-13.

Goldman, B. A., & Dickerson, C. B. (1993). A comparison of students who selected a living/learning residence hall with those who selected a conventional residence hall: A five-year follow up. The Journal of College and University Student Housing, 23(1), 35-36.

Goldman, B. A., & Hood, S. J. (1995). Residence hall longevity and transfer rates of living/learning residence hall students versus other residence hall students. The Journal of College and University Student Housing, 25(2), 38-40.

Goldman, R. D., & Hewitt, B. N. (1976). The Scholastic Aptitude Test "explains" why college men major in science more often than college women. Journal of Counseling Psychology, 23(1), 50-54.

Greenfield, L. B., Holloway, E. L., & Remus, L. (1982). Women students in engineering: Are they so different from men? Journal of College Student Personnel, 23, 508-514.

Hacker, S. (1981). The culture of engineering: Woman, workplace, and machine. Women's Studies International Quarterly, 4(3), 341-353.

Hackett, G. (1985). Role of mathematics self-efficacy in the choice of math-related majors of college women and men: A path analysis. Journal of Counseling Psychology, 32(1), 47-56.

Hackett, G., & Betz, N. E. (1989). An exploration of the mathematics self-efficacy/mathematics performance correspondence. Journal for Research in Mathematics Education, 20(3), 261-273.

Hackett, G., Betz, N. E., Casas, J. M., & Rocha-Singh, I. A. (1992). Gender, ethnicity, and social cognitive factors predicting the academic achievement of students in engineering. Journal of Counseling Psychology, 39(4), 527-538.

Hackett, G., & Campbell, N. K. (1987). Task self-efficacy and task interest as a function of performance on a gender-neutral task. Journal of Vocational Behavior, 30, 203-215.

Hackett, G., Esposito, D., & O'Halloran, S. (1989). The relationship of role model influences to the career salience and educational and career plans of college women. Journal of Vocational Behavior, 35, 164-180.

Horner, M. S. (1972). Toward an understanding of achievement-related conflicts in women. Journal of Social Issues, 28(2), 157-175.

House, J. D., & Wohlt, V. (1989). The effect of student and tutor gender on achievement of academically underprepared students in mathematics and science. Journal of Instructional Psychology, 16(4), 192-198.

Houser, B., & Garvey, C. (1983). The impact of family, peer and educational personnel upon career decision making. Journal of Vocational Behavior, 23, 35-44.

Houser, B., & Garvey, C. (1985). Factors that affect nontraditional vocational enrollment among women. Psychology of Women Quarterly, 9, 105-117.

Ivey, E. S. (1988). Recruiting more women into engineering and science. Engineering Education, 78, 762-765.

Kanoy, K. W., & Bruhn, J. W. (1996). Effects of a first-year living and learning residence hall on retention and academic performance. Journal of the Freshman Year Experience and Students in Transition, 8(1), 7-23.

Keller, J. W., Piotrowski, C., & Rabold, F. L. (1990). Determinants of career selection in undergraduates. Journal of College Student Development, 31, 276-277.

Keppel, G., & Zedeck, S. (1989). Data analysis for research designs. New York: W. H. Freeman and Co.

Koshland, D. E. (1988). Women in science. Science, 239(4847), 1473.

Lane, M. J. (1988). The current status of women and minorities in engineering and science. Engineering Education, 78, 750-755.

Lapan, R. T., Shaughnessy, P., & Boggs, K. (1996). Efficacy expectations and vocational interests as mediators between sex and choice of math/science college majors: A longitudinal study. Journal of Vocational Behavior, 49, 277-291.

Lefevre, J., Kulak, A. G., & Heymans, S. L. (1992). Factors influencing the selection of university majors varying in mathematical content. Canadian Journal of Behavioural Science, 24(3), 276-289.

Lemkau, J. P. (1983). Women in male-dominated professions: Distinguishing personality and background characteristics. Psychology of Women Quarterly, 8(2), 144-165.

Lent, R. W., Brown, S. D., & Larkin, K. C. (1984). Relation of self-efficacy expectations to academic achievement and persistence. Journal of Counseling Psychology, 31(3), 356-362.

Lent, R. W., Brown, S. D., & Larkin, K. C. (1986). Self-efficacy in the prediction of academic performance and perceived career options. Journal of Counseling Psychology, 33(3), 265-269.

Lent, R. W., Brown, S. D., & Larkin, K. C. (1987). Comparison of three theoretically derived variables in predicting career and academic behavior: Self-efficacy, interest congruence, and consequence thinking. Journal of Counseling Psychology, 34(3), 293-298.

Lent, R. W., & Hackett, G. (1987). Career self-efficacy: Empirical status and future directions. Journal of Vocational Behavior, 30, 347-382.

Lent, R. W., Larkin, K. C., & Brown, S. D. (1989). Relation of self-efficacy to inventoried vocational interests. Journal of Vocational Behavior, 34, 279-288.

Lent, R. W., Lopez, F. G., & Bieschke, K. J. (1991). Mathematics self-efficacy: Sources and relation to science-based career choice. Journal of Counseling Psychology, 38(4), 424-430.

Lent, R. W., Brown, S. D., & Hackett, G. (1994). Toward a unifying social cognitive theory of career and academic interest, choice, and performance. Journal of Vocational Behavior, 45, 79-122.

Lips, H. M. (1992). Gender- and science-related attitudes as predictors of college students' academic choices. Journal of Vocational Behavior, 40, 62-81.

Lubinski, D., & Benbow, C. P. (1992). Gender differences in abilities and preferences among the gifted: Implications for the math-science pipeline. Current Directions in Psychological Science, 1(2), 61-66.

Madson, D. L., Kuder, J. M., Hartanov, T. F., & McKelfresh, D. A. (1976). Residential academic groupings – A program evaluation. Journal of College and University Student Housing, 6, 16-20.

Magnarella, P. J. (1975). The University of Vermont's living-learning center: A first-year appraisal. Journal of College Student Personnel, 16, 300-305.

Matyas, M. L. (1992). Promoting undergraduate studies in science and engineering. In M. L. Matyas and L. S. Dix, (Eds.), Science and engineering programs (pp.43-65). Washington, D.C.: National Academy Press.

McKelfresh, D. A. (1980). The effect of living environments on engineering students. Journal of College and University Student Housing, 10, 16-18.

Meade, J. (1991). The missing piece. ASEE Prism, 1, 19-22.

Moore, D. S., & McCabe, G. P. (1989). Introduction to the practice of statistics. New York: W. H. Freeman and Co.

Morgan, C. S. (1992). College students' perceptions of barriers to women in science and engineering. Youth and Society, 24(2), 228-236.

Morishima, J. K. (1966). Effects on student achievement of residence hall grouping based on academic majors. In C. H. Bagley (Ed.), Research on Academic Input: Proceedings of the Sixth Annual Forum of the Association for Institutional Research (pp. 163-170). Cortland, NY: Office of Institutional Planning, State University of New York at Cortland.

National Research Council's Office of Scientific and Engineering Personnel Committee on Women in Science and Engineering. (1994). Women scientists and engineers employed in industry: Why so few? Washington, D.C.: National Academy Press.

National Science Board. (1993). Science & Engineering Indicators – 1993. Washington, DC: U.S. Government Printing Office.

National Science Foundation. (1994). Women, minorities, and persons with disabilities in science and engineering. Arlington, VA: Author.

O'Brien, K. M., & Fassinger, R. E. (1993). A causal model of the career orientation and career choice of adolescent women. Journal of Counseling Psychology, 40(4), 456-469.

Pascarella, E. T., & Terenzini, P. T. (1980). Student-faculty and student-peer relationships as mediators of the structural effects of undergraduate residence arrangement. Journal of Educational Research, 73, 344-353.

Pascarella, E. T., & Terenzini, P. T. (1981). Residence arrangement, student/faculty relationships, and freshman-year educational outcomes. Journal of College Student Personnel, 22, 147-156.

Pascarella, E. T., Terenzini, P. T., & Blimling, G. S. (1994). The impact of residential life on students. In C. C. Schroeder & P. Mable (Eds.), Realizing the educational potential of residence halls (pp. 22-52). San Francisco: Jossey-Bass.

Pemberton, C. (1969). An evaluation of a living-learning residence hall program. Unpublished manuscript (ERIC Document Reproduction Service No. ED 077 399).

Pfafflin, S. M. (1984). Women, science, and technology. American Psychologist, 39(10), 1183-1186.

Reddin, J. (1997). High-achieving women. In H. S. Farmer and Associates (Eds.), Diversity and women's career development (pp. 95-126). Thousand Oaks, CA: Sage Publications.

Reuss, M. C., & Vogel, R. M. (1989). Attracting today's youth to civil engineering. Journal of Professional Issues in Engineering, 115, 363-368.

Robinson, J. G., & McIlwee, J. S. (1989). Women in engineering: A promise unfulfilled? Social Problems, 36(5), 455-472.

Robinson, J. G., & McIlwee, J. S. (1991). Men, women, and the culture of engineering. The Sociological Quarterly, 32(3), 403-421.

Rodenstein, J. M., & Glickauf-Hughes, C. (1979). Career and lifestyle determinants of gifted women. In N. Colangelo & R. T. Zaffrann (Eds.), New voices in counseling the gifted (pp. 370-381). Dubuque, IA: Kendall/Hunt.

Rowe, L. P. (1979). Living learning centers: A philosophical and resource guide for residence educators. American College Personnel Association, Washington, D.C. Commission III—Task Force on Living Learning Centers (ERIC Document Reproduction Service No. ED 193 975).

Schaefers, K. G. (1993). Women in engineering: Factors affecting persistence and attrition in college majors. Unpublished doctoral dissertation, Iowa State University, Ames, IA.

Schaefers, K. G., Epperson, D. L., & Nauta, M. M. (1997). Women's career development: Can theoretically derived variables predict persistence in engineering majors? Journal of Counseling Psychology, 44(2), 173-183.

Schroeder, C. C. (1980). The impact of homogeneous housing on environmental perceptions and student development. The Journal of College and University Student Housing, 10(2), 10-15.

Schroeder, C. C., & Belmonte, A. A. (1979). The influence of residential environment on pre-pharmacy student achievement. American Journal of Pharmaceutical Education, 43(1), 16-18.

Schroeder, C. C., & Freesh, N. (1977). Applying environmental management strategies in residence halls. NASPA Journal, 15(1), 51-56.

Schroeder, C. C., & Griffin, C. M. (1976). A novel living-learning environment for freshman engineering students. Engineering Education, 67, 159-161.

Schroeder, K. A., Blood, L. L., & Maluso, D. (1993). Gender differences and similarities between male and female undergraduate students regarding expectations for career and family roles. College Student Journal, 27(2), 237-249.

Sells, L. W. (1980). The mathematics filter and the education of women and minorities. In L. H. Fox, L. Brody, and D. Tobin (Eds.), Women and the mathematical mystique (pp. 66-75). Baltimore: Johns Hopkins.

Seymour, E. (1995). The loss of women from science, mathematics, and engineering undergraduate majors: An explanatory account. Science Education, 79(4), 437-473.

Simpson, C. Baker, K., & Mellinger, G. (1980). Conventional failures and unconventional dropouts: Comparing different types of university withdrawals. Sociology of Education, 53, 203-214.

Singer, J. M., & Stake, J. E. (1986). Mathematics and self-esteem: Implications for women's career choice. Psychology of Women Quarterly, 10(4), 339-351.

Snead, R. F., & Caple, R. B. (1971). Some effects of the environmental press in university housing. The Journal of College Student Personnel, 12, 189-192.

Spencer, S. J., Steele, C. M., & Quinn, D. M. (1999). Stereotype threat and women's math performance. Journal of Experimental Social Psychology, 35, 4-28.

Stewart, G. M. (1980). How honors students' academic achievement relates to housing. The Journal of College and University Student Housing, 10(2), 26-28.

Sullivan, S. E. (1992). Is there a time for everything? Attitudes related to women's sequencing of career and family. The Career Development Quarterly, 40, 234-243.

Swanson, J. L., & Tokar, D. M. (1991). College students' perceptions of barriers to career development. Journal of Vocational Behavior, 38, 92-106.

Taylor, R. G., & Hanson, G. R. (1971). Environmental impact on achievement and study habits. Journal of College Student Personnel, 12, 445-454.

Temple, L., & Lips, H. M. (1989). Gender differences and similarities in attitudes toward computers. Computers in Human Behavior, 5, 215-226.

Vander Wall, W. J. (1972). A comparison of college environmental perceptions, academic achievement, and attrition of student participants and non-participants in a special university living-learning residence hall program (Doctoral dissertation, North Carolina State University at Raleigh, 1972). Dissertation Abstracts International, 33(8), 4134A.

Ware, N. C., & Lee, V. E. (1988). Sex differences in choice of college science majors. American Educational Research Journal, 25(4), 593-614.

Ware, N. C., Steckler, N. A., & Leserman, J. (1985). Undergraduate women – Who chooses a science major? Journal of Higher Education, 56(1), 73-84.

Williams, D. E., & Reilley, R. R. (1972). The impact of residence halls on students. Journal of College Student Personnel, 13(5), 402-410.

Williams, D. E., & Reilley, R. R. (1974). The impact of residence halls on students: The research. In D. A. DeCoster and P. Mable (Eds.), Student development and education in college residence halls (pp. 211-233). Washington, D.C.: American College Personnel Association.

Williams, D. E., Reilley, R. R., & Zgliczynski, S. M. (1980). Changing students and changing residence halls: Research and implications. In D. A. Decoster and P. Mable (Eds.) Personal education and community development in college residence halls (pp. 292-324). Cincinnati, OH: American College Personnel Association.

Wilson, L. S. (1992). The benefits of diversity in the science and engineering work force. In M. L. Matyas and L. S. Dix, (Eds.), Science and engineering programs (pp. 1-14). Washington, D.C.: National Academy Press.

ACKNOWLEDGMENTS

I would like to thank many people who have been instrumental in the successful completion of this project. Dr. Douglas Epperson stimulated my interest in this research topic and he has provided encouragement and guidance throughout my graduate experience. I appreciate his mentoring and patience throughout this process.

I would also like to thank my dissertation committee members: Drs. Doug Bonett, Fred Borgen, Susan Cross, Norman Scott, and Jane Vallier. Their interest in the topic motivated me to complete the project in a timely manner. Dr. Jane Vallier was a particularly important mentor throughout my graduate program and she is a true advocate for women served by this project's intervention.

Mary Ann Evans, Director of the Program for Women in Science and Engineering, accorded me the opportunity to evaluate the intervention's effects in the initial program evaluation and in the current study. She and the staff of the Program for Women in Science and Engineering provided significant support and encouragement throughout both studies, and I greatly respect their ongoing commitment to women studying nontraditional majors.

I am indebted to Sharon Thompson, Angelisa Braaksma, Margie Nauta, Jill Shafer, and Keri Bassman for their assistance in data collection and entry. They were always willing to stay a little longer or do one more thing, and I appreciate their cooperation and support.

A number of colleagues bolstered my motivation and enthusiasm throughout the project. Krista Krebs and Jenny Miller supported me throughout my graduate experience, and I owe the completion of my degree to their collaboration, dedication, and unfailing friendship. My degree would mean much less if I couldn't share it with them. My colleagues

at the University of Minnesota, Tim Beyer, Jane Levin, Stefanie Maxwell, Angie Schmidt, and Sarah Spreda, tirelessly encouraged me as I completed my dissertation long distance.

Finally, I would like to thank my family for their love and encouragement. Their guidance and overwhelming support encouraged my entry into the field and enabled me to reach my goals. I am most thankful to my husband and partner, Raj, who silently sacrificed much for my career aspirations and did so willingly and unquestioningly. Without him I would not have felt the confidence or motivation needed to complete my degree and would have had no one with whom to share it.