Variables related to the academic success of women engineering students

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by

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INTRODUCTION

This study investigated variables related to the academic success of women in engineering. This was addressed by research in the areas of academic achievement, attitude and anxiety toward math; retention; and the effect of a support class on women students.

To date, the reasons women are underrepresented in engineering are unclear. Many factors influence an adolescent's decision to attend college. Selection of a major area of study by a student also involves many experiences that have occurred throughout the student's life. Attitudes and actions of significant others in the lives of young people affect these decisions. Intellectual capabilities of students and academic choices early in their academic careers may eliminate choices of certain careers for some young people. Other factors may be unique to the individual, totally accidental factors or factors that defy an explanation in career choice. Regardless of the reasons for choosing a major area of study, the fact remains that a higher percentage of men choose certain careers while a higher percentage of women choose other career areas. Occupations are traditionally sex-typed as masculine or feminine. A sex-typed position is one in which a large majority of the people in the profession are of one sex and there is an associated normative expectation that this is as it should be.

Engineering is one of these career areas in which men have traditionally comprised the majority of the profession. Nationwide in 1983, women received 9,566 or 13.2% of all baccalaureate engineering degrees, 1,782 or 9.0% of the master's degrees and 142 or 4.7% of the doctoral degrees (Doigan,1984). At Iowa State University, the number of women enrolled in Engineering has increased from 18 or 0.5% in 1970 to 195 or 6.5% in 1975 to 476 or 9.9% in 1980. Currently (1984), the number of women enrolled in Engineering is 591 or 10.6%. While this reflects a steady upward trend, the rate of increase is relatively slow with a disproportionately small number of women continuing to choose engineering.

In an effort to explain why women are underrepresented in certain sex-typed positions, many variables have been examined. For example, it has been suggested that since math and physical sciences are an important and essential part of any engineering curriculum, attitude and anxiety factors of women towards these fields may result in underrepresentation in engineering. Empirical studies involving these variables provide conflicting results with some authors reporting differences (Bleyer, 1980) and others none (Warman, 1981). Thus, it is unclear whether anxiety and attitude factors related to math are more prevalent among women than men (Dreger and Aiken, 1957). No data are available to evaluate differences between women and men engineering students.

Whether or not women have skill deficits in math and science is contradictory in reported findings. Some report that skill levels of males and females were the same until puberty (Hilton & Berglund, 1974; Fennema & Carpenter, 1981), after which females did not compete as well. Males reportedly elected to take more math courses in high school (Pedro, Wolleat, Fennema & Becker, 1981; Iker, 1980). Even when the number of math courses taken was controlled, there were still differences in ability reported by some (Fennema & Carpenter, 1981) and none by others (Stones, Beckmann, & Stephens, 1982). Thus, the literature did not support or refute the societal expectation that males are superior in mathematics achievement.

Another variable which may explain the underrepresentation of women in engineering is the influence of teachers, advisors, counselors and parents. Among the women who do choose engineering, these individuals have been shown to be influential in the nontraditional choice. Teachers have been cited as an important factor in women students pursuing and achieving success in math (Becker 1981, Aiken 1970, Ernest 1976, Dutton 1965, House 1975) and subsequently being able to pursue careers similar to engineering. Also, parents are an important variable in why women choose engineering (Lebold, Linden, Jagacinski & Shell, 1981; David, 1971; Ott, 1978a). Thus, one might infer that teachers and parents who do not offer a positive influence may be responsible for a portion of the underrepresentation.

Need for Study

Women who choose engineering may be a unique group in that they have chosen a field in which they are underrepresented. However, little research data are available to confirm this. Investigations at Purdue and Cornell, show that women enrolled in engineering programs appear to be more academically qualified than men (Jagacinski & Lebold, 1981; Ott, 1976). Attitude and anxiety factors toward math and science for women engineering students have not been explored.

In addition, because women comprise such a small percentage of the engineering student population, the issues of retention or persistence become critical. According to Ott (1978b), retention rates for women engineers were significantly different from men with more men being persisters. Also, men and women appeared to be leaving for different reasons. Since research on retention of women engineers was limited, this study was designed to address the issue of retention of women students in engineering.

Due to the underrepresentation of women in engineering, support or intervention to try to increase the size of this group is needed. The effectiveness of role models (Rudnick and Kirkpatrick, 1981), peer support (Lantz, 1982) and support classes (Butler, 1979) has been reported for groups other than engineers. The current study developed a curriculum in which these factors were incorporated and subsequently evaluated its effectiveness in retaining women undergraduates in engineering.

Purpose of Study

The first purpose of this study was to gather information about women and men entering engineering at Iowa State University in order to determine if women are different from their male colleagues in terms of achievement (as reflected by ACT scores, high school rank, and math placement scores) and attitude and anxiety factors toward math.

The second purpose of this study was to investigate retention of women engineers compared to their male peers.

Are the retention rates similar and do men leave engineering for the same reasons as women?

The third purpose of this study was to ascertain the effect of special intervention and support for women who have chosen a nontraditional major, engineering.

Research Hypotheses

1. First, it was hypothesized that women entering engineering would be superior to their male colleagues in high school rank, ACT scores, math placement scores, grades in math, and number of math/science courses taken in high school. Since this group was assumed to be an atypical subset of all women high school graduates, its members were hypothesized to have superior academic achievement and experience compared to the large diverse male group.

2. Second, it was predicted that women entering engineering would not differ from their male counterparts in attitude and anxiety factors toward math. The asssumption on which this hypothesis was based was that women who choose a nontraditional field like engineering must be a unique group in terms of their attitudes relating to traditional roles and values associated with the sexes and thus they would not manifest the attitude and anxiety factors toward math that society ascribes to women.

3. Third, it was expected that retention of male and female students in engineering would be similar but the reasons for being nonpersisters would be different. Women in engineering were expected to transfer to other majors more frequently than their male colleagues. Males in engineering were expected to experience academic difficulties more than their female colleagues.

4. Fourth, it was hypothesized that women students in engineering who attend support classes designed to meet the needs of women in engineering would have higher retention rates. They also would be better adjusted to nontraditional fields, would have more female role models, more peer support and support from others for their nontraditional career choice, be more informed of opportunities for women in engineering and have more confidence in their ability to become engineers than women who did not attend support classes.

Limitations of the Study

The major limitation of this study is that it was conducted only with engineering students at Iowa State University. Therefore, generalizing the findings of this study to other universities or other academic majors should be approached with caution. Secondly, in order to measure many characteristics of interest, it was necessary to rely on self report. Students may not be aware of their feelings or may be hesitant to report their true feelings. These limitations should be considered when reviewing the results of this study.

REVIEW OF LITERATURE

The areas of academic achievement characteristics of students as they relate to academic success, student retention, and support groups for women will be addressed in this literature review. The three major purposes of this study were to compare women and men engineering students in terms of academic characteristics, to determine retention rates and to ascertain the effect of interventions for women in a sex-typed curriculum. This chapter will first summarize the academic achievement characteristics of college students and other variables affecting academic success. Information regarding math performance will be explored since math performance appears to be closely related to success in engineering. In addition, research concerning other factors relating to success in Engineering will also be reported. These include retention studies particularly as they relate to engineering and the differences in the sexes. Finally, the literature relating to support groups or interventions for women in nontraditional academic areas will be reviewed.

Variables Relating to Academic Success in Engineering

A body of literature has been generated recently in relation to the math skills of entering freshmen and the variables affecting success in college mathematics courses. Success in mathematics classes often determines whether a student can be successful in a high technology curriculum like engineering. Sells (1975) refers to the "critical filter" in making career choices due to a lack of math competencies.

Math performance

Research regarding sex-related differences in math performance has received a high degree of attention and much of this information is contradictory particularly when discussing students of pubescent age and beyond. There is little, if any, evidence of sex-related differences among younger children.

Achievement and skills   Fennema and Carpenter (1981) found little difference in overall math achievement between boys and girls at age nine to thirteen. However, with an increase in the age of students and even with the number of high school math courses held constant, boys achieved more than girls. Differences were greater the more complex the task.

Stones, Beckmann and Stephens (1982), on the other hand, reported that competencies were the same when mathematical course background was considered. They noted that males scored significantly higher in geometry, measurement, probability and statistics and business and consumer math while females scored significantly higher in mathematical sentences and mathematical reasoning. The areas in which females performed better were areas in which the ability to reason mathematically was important but specific course content was not important. The areas in which males performed better were areas in which specific course content was important. It was also noted that males put more effort into mastering traditional courses encountered in high school. In 80% of the sub-categories they measured, there were no differences in male and female achievement. Stones et al. attributed the differences that existed in math ability to the role society had created for males and females.

Astin (1975) investigated quantitative, verbal, and reasoning factors in an effort to examine possible sex differences in math abilities. Significant differences by sex were found in 17 of 30 tests. Females scored higher in 6 of the tests, primarily those involving verbal ability and perceptual speed and accuracy. Males scored higher in 11 of the 17 tests, mainly those related to specific mathematical processes. Like Stones et al. (1982), Astin attributed these differences to differing cultural expectations for men and women.

Fennema and Sherman (1977) collected data from students in grades 9-12 in 1975 and students in grades 6-8 in 1976. In this comprehensive study, they found that regardless of age or level of difficulty, males were not superior in math achievement or spatial visualization. This study differed from many studies in that the researchers controlled for previous math background. These data indicated that the differences were not so much in innate abilities but in socio-cultural differences.

Testing Sex differences have been found in the performance on tests such as the Scholastic Aptitude Test (SAT), a college entrance exam with a mathematical component given to high school juniors and seniors (Fennema, 1980). Over a period of years, women have scored lower than men. In 1960, the mathematical component means were 465 for women and 520 for men. In 1972, the average for women was unchanged but the average for men had dropped to 506.

An attempt has been made to explain this disparity in test scores. Researchers (Plake, Ansorge, Parker, and Lowry, 1980) reported that the effects of item arrangement on tests correlated with sex. Sex interacted with item arrangement yielding the highest scores for males with an easy-hard ordering out of a possible four types of ordering (easy-hard, uniform, spiral cyclical, and random).

Similarly, a study by Benbow and Stanley (1980) also showed males performed better on the SAT-Math test, a test with easy-hard ordering.

Fox (1977) analyzed the California Achievement Test, Iowa Test of Basic Skills, Metropolitan Achievement Test and Sequential Tests of Educational Progress. She found that male nouns outnumber female nouns in the language on the exams. There was some controversy over whether the wording of math problems differentially affects the student's ability to complete problems successfully. Females did better on a problem when the setting of the problem was buying yard goods in a fabric store than when the setting was buying stock at a stock exchange. When the characteristics of a problem were altered to make them less masculine, sex differences in problem-solving ability were reduced. While more information is needed on various features of the item content and context in tests and how these features affect performance, Fox considered test performance to be a less crucial issue in differential math performance than course-taking.

Math background

As mentioned in the previous section, Fennema and Carpenter (1981) reported that even with the same math background, males achieved more. Stones et al. found that with the same math background, overall competencies were the same. The latter researchers, however, found that in mathematical areas (reasoning, measurement, etc.) males and females differed significantly.

Some of the sex-related differences in math were explained in number of courses elected. Males elected more advanced math courses than females. The percentage of females enrolled in high school mathematics classes decreases proportionally with grade level (Pedro, Wolleat, Fennema and Becker, 1981). Iker (1980) reported 57% of incoming males and 8% of incoming females at the University of California at Berkeley in 1973 had taken four years of math. At Berkley, the critical filter concept has implications for women as sixty-nine of one hundred twelve academic majors at Berkeley require advanced high school math courses as prerequisites.

Warman (1981) conducted research to study attitudes of Home Economics students toward learning math. This population was primarily female. They were compared with a group of undeclared Science and Humanities students that included both males and females. Of the total males in the study, 68.6% had more than three years of high school math as compared to 45.9% of the females. Women did have less mathematics preparation than men, and women in Home

Economics had fewer high school mathematics courses than the undeclared women in Sciences and Humanities.

Iker (1980) summarized the results of several comparable studies completed with differing results. He pointed out that 63% of males and 43% of females had four years of high school math according to seniors who took the College Board Exams in 1978. On the other hand, he cited a study by Jane Armstrong of the National Asssessment of Education Progress which showed a 41% to 37% male/female ratio among those electing four years of high school math. Finally, according to Iker, psychologists studying students in four locations found similar numbers of boys and girls in advanced math courses. This lack of consistency among studies may be due to the different geographical areas being studied or to shifts that are occurring in the percentage of females taking advanced math courses. In summary, differing amounts of high school math preparation for male and female students has been shown in some studies and not in others.

Math attitude

Some researchers have tried to elucidate the exact attitudinal differences between the sexes. Fennema and Sherman (1976a) have used the Fennema-Sherman Mathematics Attitude Scales, a scale developed to measure attitudes toward the learning of mathematics by males and females.

Nine major areas of attitude were investigated. The attitude toward success scale was used to measure whether the student reacted in a negative or positive manner to success in mathematics. Another scale measured whether a student perceived math as a male-domain area, a neutral area, or a female-domain area. A mother/father scale measured how the student perceived interest and encouragement from each parent. Teacher's attitudes toward the student as a learner as reflected by encouragement and confidence in the student's ability was measured by the teacher scale, while confidence in one's own ability to learn was measured by the confidence scale. The mathematics anxiety scale was intended to measure feelings of anxiety, dread and nervousness and body conditions related to those feelings. The effectance scale measured involvement in mathematics. The last measure was the usefulness scale and this reflects the students' perceived usefulness of mathematics courses in the future.

Using this attitude scale, Fennema and Sherman (1977) found a pattern of differences in four high schools located in Wisconsin. In School 1, sex-related differences in math achievement and on five attitude scales were reported. School 2 reported a sex-related difference in spatial visualization only and on one attitude scale. In School 3, three attitude scale differences existed. In School 4, sex-related differences were found in mathematics achievement, spatial visualization and on six attitude scales. In general, schools which reported significant differences for the sexes in math achievement also had significant differences in attitude (5 or 6 of the scales).

Many of these attitudinal differences among males and females were of interest. In all four schools, boys rated mathematics more of a male domain than girls did. Males scored significantly higher in confidence levels at three schools. Females reported less positive perceptions of their mothers attitude (three schools) and their father's attitude (two schools) than the males. They also reported math as being less useful than the boys (three schools).

Just as the Fennema and Sherman (1977) study indicated a relationship between math achievement and math attitude, Warman (1981) reported that students with less preparation had less positive attitudes. Attitudes toward learning mathematics were the same for the male and female group when preparation was considered.

Math anxiety and confidence factors

Another variable which has been studied in relation to math performance is math anxiety. Math anxiety has been defined as "feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations" (Lazarus, 1974, p. 16). Another term used to describe math anxiety, mathophobia, has been defined as "an irrational and impeditive dread of mathematics" (p. 16).

Studies of the effect of anxiety or test anxiety on math performance yielded differing results. Dreger and Aiken (1957) reported that number anxiety correlated inversely with final math grades. Later research was unable to find a relationship between achievement anxiety test scores and math performance (Towle and Merrill, 1975). Many individuals who do not suffer from other tensions suffer from math anxiety according to Richardson and Suinn (1972). Over one third of the students in a behavioral therapy program had a problem with mathematics anxiety as measured by MARS (Math Anxiety Rating Scale), a test used for identifying students with math anxiety.

Morris and Liebert (1970) found a negative correlation between worry and grade. Worry was defined as "expressions of cognitive concern about one's performance". Emotionality, defined as "affective reactions to the stress of the test situation per se," was unrelated to grade (p. 332). Based on their research, the investigators concluded that different components of anxiety affected performance in a different manner.

Whether students were rule-oriented or concept-oriented was another variable studied. Resek and Rubley (1980) found that students who were concept-oriented as opposed to rule-oriented were more successful in math. They developed a program to move students from concentrating on rules to thinking in terms of the concepts involved. They developed a test to identify students who were rule-oriented. In their discussion of the results, the team found that rule-oriented students were more likely to become concept-oriented when grouped together in sections, since they were less anxious when grouped with students like themselves. The authors believed there was a connection between movement to becoming concept-oriented and reduction in math anxiety. The rule-oriented group needed more time and worked better in small groups than concept-oriented groups. The evidence indicated that more students can come to a conceptual view of mathematics if allowed time to explore and absorb concepts and feel comfortable with the material. The authors suggested a difference in teaching strategies is particularly needed in mathematics. The sample in this study was 75% women, 41% over the age of 22, and 66% non-white.

Tobias (1980) reported that one key difference between mathematically capable people and math anxious people was their attitude toward error. She noted that math anxious people tend to memorize and then panic if their memory temporarily fails them. They also believed they should successfully solve a problem in one attempt. Others would be content to work away at a problem making very little gain. Many math anxious people were guilty of self-defeating talk. These differences were not due to variations in intelligence or ability, but rather a result of differences in attitude, temperament, approach and feelings that form early in a child's schooling.

Another concern for math anxious students was voiced in the Tobias article. "Almost everyone who works or wants to work in a large organization, public or private, must become familiar with the powers and limitations of computer systems. To be able to ask intelligent questions of data processors means one must at least be familiar with computer technology. People who are math anxious or who have avoided mathematics for many years may be put off by computer logic, computer language and systems-think" (p. 48).

Finally, a study by Betz (1978) related math anxiety to sex. Utilizing 652 subjects in a large midwest university, Betz indicated that math anxiety occurs more frequently among women than men and more frequently among students with poor high school background than with good high school backgrounds.

Effect of significant others

According to several researchers, significant others in the lives of students affect academic achievement in math. These significant others may include parents, peers, and school personnel such as teachers and counselors. Several studies have examined whether or not individuals in these groups affect males and females differently.

Teachers and counselors Becker (1981) studied the possibility of differential treatment of females and males by math instructors. He found that males received more teacher attention and reinforcement. This study conducted in 9th and 10th grade geometry classes focused on six categories of student-teacher interactions. The categories were as follows: direct questions (teacher calls on student by name), open question (teacher asks a question, waits for students to raise hands, then calls on a volunteer), process questions (higher order teacher questions), product questions (lower order teacher questions), call-outs (teacher asks a question, student calls out an answer), and student-initiated interactions (student public questions, individual academic and non-academic contacts). Of the six categories, only student-initiated interactions occurred more often with females than with males. Encouragement of students showed a wide disparity between males and females as males received 70% of all positive contacts while females received 84% of the nonencouraging or discouraging comments from teachers.

In a review of research from 1960 to 1970 concerning attitudes toward math, Aiken (1970) concluded that "of all the factors affecting student attitudes toward mathematics, teacher attitudes are viewed as being of particular importance (p. 590)." The importance of the teacher's attitude was further explored by Ernest (1976). In a sample of elementary and high school teachers, 41% believed boys did better in math. Ernest felt that the reason teachers believed that boys did better was that they expected them to do better. This is commonly referred to as the "Pygmalion effect" in education, in which the student performs to meet the expectations of the teacher.

Other research indicated that many teachers do not have favorable attitudes toward arithemetic. In a 1962 study conducted by Dutton, 38% of 127 elementary education majors had favorable attitudes toward mathematics. In a follow-up study, Dutton (1965) tested these elementary education majors before and after a mathematics education course.

Even after instruction, the rise in mean attitude score was insignificant. Twenty-five percent of the prospective elementary teachers maintained an unfavorable attitude toward mathematics.

Teacher attitude toward students affected the student's self-concept according to House (1975). In a study of over 1,000 junior and senior high school students in 115 schools, House reported that significant numbers of students were being needlessly hindered not by lack of ability, but by inadequate self-concepts. She also emphasized the importance of minimizing favoritism in the classroom. In the same study, cliquishness was found to correlate positively with self-concept. Being a part of a group that studies mathematics together and does well in mathematics was seen as an advantage.

Guidance counselors were cited as having a negative attitude toward math in a study on factors affecting female participation in advanced placement programs (Casserly, 1980). Curriculum, guidance policies, and student cultures were examined in thirteen high schools. Most counselors had little or no background in the physical sciences. They believed that advance placement (AP) math and science courses were "practical and proper" for males. The study found that the counselors often regarded the boys' interests in such courses as more "legitimate" and they were given preference when places were limited. In this study, the guidance counselors were usually viewed in a negative light by the AP teachers. Quotes from two guidance counselors illustrate the attitudes faced by young women in many of the secondary schools.

> A counselor in her 20s: "I just hate to see a girl get in over her head. I always try to place students at a level where I know they'll be successful. I mean wouldn't it be frightful to spoil a beautiful record by doing poorly in a course your senior year?"
>
> A male director of guidance in his mid 40s: "Sure I'm for the AP program in general, but not for encouraging girls in science necessarily. Have you looked at the Bureau of Labor Statistics? It's a contracting market. There are men with Ph. D.'s in physics all over the place who can't get jobs. Why if they're successful, they'd be taking jobs away from men who need them. No, it wouldn't be fair to the girls (Casserly, 1980, p. 157).

These comments along with others were listed by Casserly not because they were unique but because they represented the attitudes of counselors in many schools. Along the same line, Haven (1972) reported that 42% of the young women who were interested in careers in mathematics or science reported being discouraged by counselors from taking advanced math courses.

Finally, it is not unusual to find teachers fulfilling the counseling function with their students. According to Casserly (1980), when teachers do take an active interest in recruiting girls into mathematics programs, the results were very positive. Effective career and college counseling took place in AP classes and Casserly recommended that schools should encourage AP teachers to serve this function.

Parental influence Parents may be transmitting conflicting aspirations to their female children according to data collected from the parents of 125 women (Casserly 1980). One father reported that he did not expect his daughter to work after she was married, but his career aspiration for her was to become a doctor.

Parents were also asked how important a knowledge of mathematics would be for their child's future career. The boys' parents perceived math as more important for their children's future career than the girls' parents. Fifty-eight percent of boys' parents considered math very important, whereas only 38% of girls' parents did. This difference in perceived importance of math may result in a difference in encouragement and support to take advanced math classes.

In one study (Fox, 1977) of mathematically-gifted students, boys reported their parents as favorable to the accelerated math program more frequently than the girls. The parents of the boys also bought more math games and toys, and recognized the child's abilities at an earlier age than did the parents of gifted girls. Parents also discussed college and career plans more and at an earlier age with their sons.

Perceptions of fathers' expectations but not fathers' attitudes or professions were related to taking advanced math classes and achievement of young women (Fox, 1977). Fathers who sex-type math were less likely to convey high math expectations to their daughters. Also, maternal expectations for girls toward mathematics were important, and the girls' perceptions of parental expectations were important.

Peer influence One study (Solano 1977) of adolescents found that adolescents hold a more negative stereotype of mathematically-gifted girls than gifted boys. Thus, girls may be perceiving peer pressure not to succeed in mathematics.

Fennema and Sherman (1976b) noted that women live in a society where the women's movement receives much publicity. While women may agree that it is just as appropriate for women to study math as men, when they are faced with male peer rejection, they behave in a stereotypic fashion toward course selection. This study showed that boys, more than girls, rated math as a male domain. Fennema and Sherman suggested that this masculine viewpoint is communicated to women in the form of subtle peer pressure.

According to Brody and Fox (1980), when the number of girls was small, girls begin to drop out of classes, presumably because the class had become too much of a "male domain". Thus, he asserted that advanced mathematics classes for the gifted need a minimum number of girls so that girls would continue and succeed. If the perception of mathematics as a male domain is common in a peer group, girls may fear peer rejection and avoid advanced mathematics.

Academic Difference in Women and Men in Engineering

How do all these factors relating to math and academic success in the population as a whole relate to women who choose engineering? These individuals have made a nontraditional curriculum choice. Are their math competencies similar to the population as a whole or are they different?

Women engineering students studied at Purdue consistently achieved higher mean verbal scores than men but their math scores were not significantly different (Jagacinski and Lebold, 1981). The women students also had higher high school ranks and higher high school grades in English, math, and science than the male freshmen engineers. Thus, the females seemed to be better prepared for college, especially in their verbal ability and high academic performance. Once at college, the women students had slightly higher grade point averages; in many cases, these were significantly different. An analysis of covariance indicated that the differences were not significant when SAT and high school rank were considered. These results suggest that women who choose engineering may be different than women in the population as a whole.

Other research dealing specifically with men and women in engineering was conducted by Ott (1976) at Cornell University. Major differences were found in prior academic achievement as well as academic expectations. More women than men were in the top 2% of their high school classes (40% to 20%), had A or A- grades, and received academic honors in high school. One possible explanation was the women also reported spending significantly more time on homework in high school. Ott found differences between the sexes in academic backgrounds and attitudes, extracurricular activities and cultural interests, field or major choice (a significantly larger proportion of men than women select mechanical and electrical engineering while the reverse is true for chemical engineering), family background, and marriage-career concerns.

In regard to marriage-career concerns among the engineering students, results concerned students' preferred situation regarding career and marriage 10 years after graduation. More men than women preferred to be single. A significantly larger portion of women would prefer their husbands to have a full-time job and no children than the proportion of men who would choose this option for themselves. More women than men preferred that women have no children and work full time. More men wanted women to have children and not be employed. Ott (1976) reported that "men and women agreed fairly well in regard to family-career preferences for men, but disagreed radically on family career preferences for women" (p. 232).

Gardner (1976) found engineering men and women had about the same grade point averages over a three semester period. On entrance, the females had a higher record of academic achievement, yet the males performed better than the females first semester. The margin decreased second semester and similar grade point averages existed by the third semester. The reasons for this pattern were not ascertained but Gardner speculated that women may have poorer performance due to an unwillingness to participate in a very competitive environment initially, and adjustments were made in their attitude over time. He also noted that within engineering, certain majors were attracting a disproportionate number of males with more males selecting electrical and mechanical and more females selecting chemical and civil and environmental engineering. Women and men were not disproportionately represented in other engineering programs. Gardner also found that the attitudes of the women in regard to expectations, satisfactions and future rewards changed to become more like their male peers after several terms.

After reviewing the literature concerning variables affecting academic success, it appeared that success in any curriculum is dependent on numerous and interdependent variables. Studies that related specifically to engineering, while limited in number, seem to indicate that differences between men and women in engineering may be minimal with women having a higher record of academic achievement up to the point of entering college. More information about this unique sub-group of the population is needed.

Retention Studies

In attempting to explain the phenomenon of "student dropout", much remains unknown. The variables affecting success discussed in the previous section are contributing factors. The reasons or variables responsible for "student dropout" are complex, interrelated and numerous.

Variables involved

In a conceptual schema for dropout from college, Tinto illustrates how many interrelated factors may contribute to dropout from higher education.

As can be seen from Figure 1, family background, individual attributes, pre-college schooling, grades, social factors and peer factors are all included as variables in this model explaining why students do not stay in school. Not only are the factors affecting retention for a student population complex, but an added complexity is interjected when one assumes that each one of these factors might be different for the sexes. Finally, perhaps some of these factors such as peer-group interactions, faculty interactions, family background, and goal commitments would also influence men differently than they would influence women in nontraditional majors.

Many retention studies have been completed in recent years as college and universities become concerned about declining enrollments. Some of these studies may shed some light on why students are not retained in engineering colleges also.

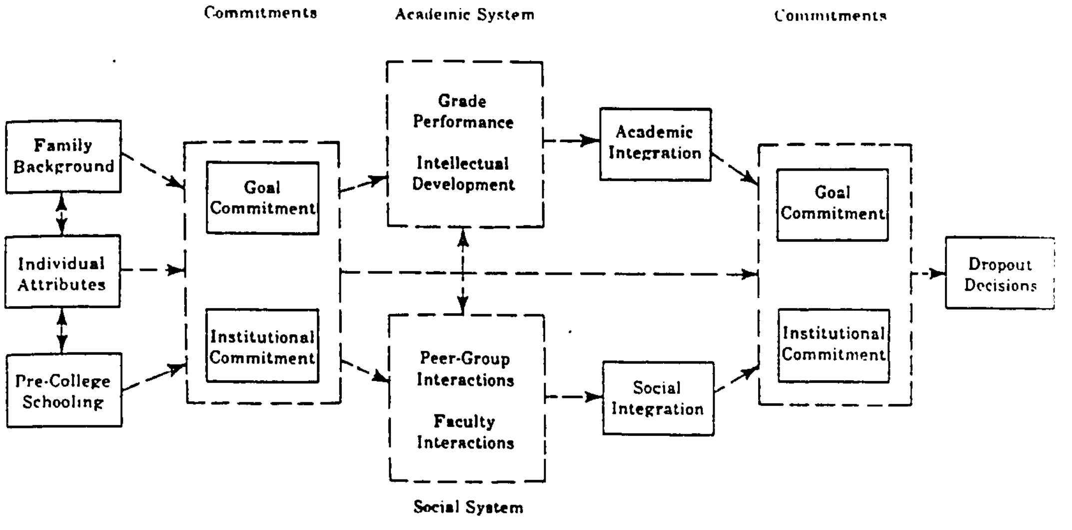

FIGURE 1. A Conceptual Schema for Dropout from College (Tinto, 1975, p. 95)

In a study by Dullam and Dawes (1981), ACT was found to be a reasonably good predictor of retention, and first semester g.p.a. was found to be the most potent predictor of graduation. Newlon and Gaither (1980) found no significant difference in verbal Scholastic Aptitude Test (SAT) scores between persisters and nonpersisters in the California State University and College system. A significant difference (.01 level) did exist for math SAT scores with those students with the higher scores being persisters. Therefore, this study indicated math competencies were a predictor for college persistence even when all academic majors were included.

Other authors, Pantages and Creedon (1978), refer to a "best fit between college and student". Each student comes to college with certain skills, attitudes, and expectations and the college demands certain skills and attitudes before it grants a degree. If these two sets of characteristics do not match, the student is more likely to drop out. They made two recommendations. First, the causes of attrition must be identified and second, the entire faculty and staff need to be involved in solving the problem.

Chickering (1974) speaks of a "comfortable fit" of a student within a college environment and indicates that every institution has "misfits". Examining sub-groups of similar students in different colleges revealed these students may be misfits in some college but not at others. Misfits who persisted for four years changed as a consequence. Characteristics of the misfits who left (compared to misfits who stayed) were more autonomous, more impulsive, more complex, more tolerant of ambiguity and more creative. Chickering addresses the importance of helping these misfits survive by developmental programs or helping them move on to an environment with confidence and positive feelings. Studies (Tinto, 1975; Pantages and Creedon, 1978; and Chickering, 1974) have indicated that retention is based on complex, numerous and changing variables.

Academic advising

Academic advisement programs have been acclaimed by Habley (1981), Jose (1978), and Crockett (1978) as the key to retention. Developmental advising, career planning, providing information about educational options, policies and procedures, monitoring and evaluating student progress, helping students plan programs consistent with their abilities and interests, and helping students clarify their values and goals are all functions of a strong academic advisement program. Academic advising can truly be a "cornerstone of student retention" according to Crockett (1978).

Solving retention problems

Other retention studies have approached retention by trying to solve the problems that cause attrition. At the University of Missouri-Kansas City, an attempt was made to break the attrition cycle by providing supplemental instruction to students (Blanc, Debuhr and Martin, 1983). They found that students in the high risk (bottom quartile) group using the service had average course grades of C- as compared to D- in the control group. They also found the services being utilized by low risk students and retention for these students was also increased. Similar findings were reported in studies by Lauridsen (1980), Martin and Blanc (1981), and Frank and Kirk (1975).

Iowa State University (Warman and Swenson, 1983) reported success in retaining students with low grade point averages after their first semester at college by having a diagnostic and prescriptive interview with an advisor. Freshmen students who were given timely information about resources available to solve their academic problems made better grades during the next academic term. Solving retention problems by providing immediate support services appears to be utilized by many institutions.

Sex differences in retention

Sex of the individual was also related to college persistence with more men finishing college degree programs than women (Astin, 1972). Of those who drop out, a greater proportion of women tended to be voluntary withdrawals than academic dismissals, whereas the reverse was true of men (Astin, 1972; Spady, 1970). Spady (1970) also found that aspirations were more closely tied to actual attainments for the women than for men. Women who wanted to finish college were more likely to do so than were men with similar aspirations. Coker (1968) and Spady (1971) found that grade performance was more important for male students than female students. This was especially true during the first year of college when most academic dismissals among males occur. Spady (1971) also found that males more than females were concerned about the extrinsic rewards of the academic system (grades) than about the intrinsic rewards (intellectual development) because of the pressure they felt for future occupational placement. In summary, dropout appeared to be related to a variety of factors, but in apparently different ways for males and females.

Engineering retention studies

A few retention studies limited the participants to a special sub-group of the student population - women and men engineers. A comprehensive study was conducted in 42 schools by Ott (1978b) of Cornell. Retention rates after 1.5 years of college was 73.3% for men and 67.8% for women engineers and this difference in retention was significantly different at the .01 level. An examination of student characteristics that differentiated between the retention and non-retention groups for both men and women revealed that the retention group had the following attributes: higher achievement, expectations and motivations; more likely to have considered other fields of study before choosing engineering; and more positive parent attitudes toward college attendance. Differences between the two groups for men but not for women were self-confidence, type of secondary school and favorite high school subject. Specifically, men who thought they would rank high in their classes had higher retention rates. Men who graduated from public high schools had higher retention rates than men who attended private high schools. The retention rate was higher for men whose favorite subject in high school was math as opposed to another subject. For women but not for men, the differentiating traits between the retention and non-retention groups were father's highest degree, race, time spent on homework in high school and family-career plans. Among women, those who were retained were more likely to have a father with a B.S. degree, be Caucasian, and completed two or more hours of homework a day in college. Retention was higher for women who planned to marry, have children and work part time than for those who planned to work full time.

Ott (1978b) also investigated the destination of the non-retained group and noted the following results:

Destination	Men (n=136)	Women (n=155)
1. Temp. leave of absence	5%	3%

2.	External transfer - eng.	3	2
3.	External transfer - other	7	8
4.	Internal transfer	43	68
5.	Academic failure	24	10
6.	Leaving without academic fail.	18	10

The major way in which men and women differed in this study was that women had higher internal transfer rates. Reasons for these transfers were not ascertained but would be interesting to know. The reasons associated with academic failure in this study may be due to the better high school achievement of the women subjects on entry which were discussed in a previous section.

Foster (1976), found persisters in engineering to be more motivated, more committed to engineering and have stronger high school records. The self-image of persisters was stronger and they viewed their academic environment in a more positive way. Foster's study did not differentiate between the sexes.

Self image or expectancy may account for why some women do not persist in engineering. After analyzing information collected on a survey on career patterns, David (1971) concluded that women are expected by others to do more poorly at numerous tasks than men. For all the professions used, including pediatrician, writer, child psychologist, surgeon, dancer, diagnostician and clinical psychologist, males were expected to be more successful than females. These lower expectations may affect performance.

Sproule and Mathis (1976) conducted a survey of 29 engineering schools that had 30 or more women engineers to find techniques used in recruiting and retaining women engineers. Eight techniques were listed as valuable:

> "1. Make a commitment to recruit and keep women engineering students. 2. Publicize your engineering program to prospective students. 3. Recruit prospective women students at the high school level. 4. Counsel women students after they arrive on campus. 5. Establish a student section of the Society of Women Engineers (SWE). 6. Hire women faculty and administrators. 7. Recognize outstanding women students. 8. Publicize opportunities for engineering graduates" (Sproule and Mathis, 1976).

All the universities surveyed reported success in recruiting and retaining women students with the simple techniques listed.

Support and Intervention

Despite the increasing numbers of women in engineering, they still remain a minority and as minorities may need special support and intervention. This section will discuss support and intervention in four different areas. First is people related support or the effects of parents, teachers, role-models, etc. Next, is social support and the critical mass theory. Support classes and their successful use is the third type of support. The holistic approach to support will be discussed last.

People-related support

Numerous reports have pointed to the importance of family members as important in influencing the decision to study engineering. At Purdue (Lebold, Linden, Jagacinski and Shell, 1981), 61% of the females said encouragement from fathers was an important factor in their choosing engineering. Ott (1978a) reported the same phenomenon except she found fathers to be influential in the decision for white women but not black women. According to David (1971), female science and engineering students were offspring of fathers of very high or very low education. Young women of the upper-class have fathers whose high educational level has given them the "sophistication to accept all areas of knowledge as desirable" whereas the lower-class girls have fathers who see the "practical as having the most powerful appeal." Fathers were viewed as a significant influence by many researchers (p. 51).

A majority of Purdue women engineers (61%) ranked fathers more important in their decision to become engineers than any other group (Lebold et al., 1981). High school math and science teachers were an important influence for

47%, college teachers for 50%, and mothers for 49%. Guidance counselors were an influence on the decision to choose engineering for only 18% which substantiates earlier literature citings of the perceived negative influence of guidance counselors.

Rudnick and Kirkpatrick (1981) reported on the importance of role-models. They also believed that parental influence was by far the most important influence on the decision to study engineering. In contrast to earlier reported research, they found mothers most influential with their daughters and fathers most influential with their sons. Once again, only a minority indicated that a guidance counselor had influenced their major choice.

Critical mass theory

The theory of critical mass postulates that "once a certain proportion or number (mass) of a population is present, recruitment and retention of that population becomes a self-sustaining and self-perpetuating system" (Lantz, 1982, p. 731). The critical mass is thought to be somewhere around 15 to 20%. An extension of this theory is that one of the best ways to attract women or minorities is to already have some. According to Lantz, this questions the practice utilized from college committees to business divisions to the Supreme Court of the United States of placing token females or minorities in isolation positions. This may do very little to increase numbers of minorities if the critical mass theory is correct.

The critical mass theory was tested in a law school where no more than 15% were women and one in which less than 35% were women. The study found that women in the law school that had 15% women or less did not do as well academically, were more socially isolated, and were more likely to demonstrate traditional female preferences in study strategies and career choices than women in the law school with a higher proportion of women.

Lantz (1982) conducted a survey of 9 engineering schools with women (one third with low, one third with mid range and one third with high critical mass). The range of critical mass was 6% to 19%. The study reported lack of confidence, social isolation and dissatisfaction among the low critical mass group. Research of this nature is restricted because very few engineering schools have female enrollments in excess of 20%.

Support classes

Support classes are another approach to intervention for the nontraditional major. Support classes or workshops have been utilized to attract women to these majors. At the University of Idaho, Hager and Thomson (1976) hold a 4 week, 6 hour a day workshop to attract young women into the engineering curriculum. Women completing their junior year in high school were exposed to computer applications, complex problem-solving and exercises that point to the diversity of engineering. Of the twelve women in the program, all had g.p.a.'s above 3.6. Before the workshop, only one of the women had considered engineering as a possible career choice. As a result of the workshop, all twelve thought engineering would be considered as a career choice.

Workshop participants at Purdue (Shell, 1982) changed their opinions as a result of the workshop experience. The students in this group were 90% black, 51% male and primarily (75%) 14 years old. At the beginning of a workshop, 76% thought white Americans had better opportunities in engineering. At the conclusion, only 55% felt this way. Similar opinions were expressed with respect to opportunities for women in engineering. At the beginning, 74% thought men received more opportunities than women and at the end only 55% expressed that opinion.

Support classes were used for women engineers at Purdue (Butler, 1979) with three main goals in mind. First was to provide role models, second, to show how engineering relates to current problems and third, to demonstrate how engineering relates to many disciplines. The course also included hands on laboratories to familiarize students with tools and equipment, and career counseling. They found the course to fulfill a real need, especially the hands-on lab experiences for women.

In summary, different types of support or intervention have been utilized. Career-education classes, counseling programs, programs that broaden women's career horizons, change their course-taking plans or increase their self-confidence have all been utilized. Workshops designed to expose students to role models have been utilized for years. Work-internship-mentor types of programs have also been employed. The support and intervention programs were many and varied (Fox, 1980).

Holistic approach

The holistic approach to women in engineering programs is utilized at Purdue (Daniels, 1982). The philosophy of these programs appear to be the following: do many types of programs for women and do the programs well by having sufficient funds, admimistrative backing and trained personnel. The womens' programs in engineering at Purdue utilize a comprehensive approach. A pool of student names is developed by using college entrance exam information. Students receive information on seminars, career days and information targeted for specific groups (women, high academic risk, minorities). Teachers and talented students are invited to luncheons in target cities. Scholarships are given to the most outstanding student who attends at each location. Summer engineering seminars are held and one third of the students who attend summer seminars come to Purdue and major in engineering. Mass mailings are sent to talented women from the women-in-engineering coordinator. Career days are held which feature women engineers. The dean holds seminars for math and science teachers. The Society of Women Engineers (SWE) holds a phone-a-thon to newly admitted women. Feminengineer newsletter is sent to prospective students. Retention programs include a support course, an active SWE chapter and an active industrial relations program. This holistic approach has helped Purdue reach an enrollment of women in excess of 20% while many engineering schools are much less.

The holistic approach was reported to be effective in a study by Connolly and Porter (1980). Their study included 60 extreme case (high and low percentage of women) schools. They reached five conclusions. The best predictor of the percentage of women in 1976 was the percentage of women in 1972. This conclusion would support the critical mass theory. Direct mailings were successful in attracting women. School quality was the second best predictor of women being attracted to an engineering program. The presence of a designated person responsible for women in engineering efforts and the percentage of women housed on campus were the last two variables that related to attracting women although they were not as important as the first three factors.

Entry of women into engineering is truly a complex phenomenon. Many aspects of this phenomenon have been discussed. Math achievement, attitudes, and anxieties and the cultural situations women face from significant others when they make nontraditional choices have been discussed. Recruiting, retention, and support groups are all very broad topics that offer some explanation of this phenomenon. Despite all the efforts to increase the percentage of women in nontraditional fields such as engineering, the results of these efforts have not been realized. Women continue to be disproportionately represented at all engineering schools.

METHODOLOGY

This research had three main purposes. Academic achievement, math anxiety and attitude, retention, and the effect of support classes for women engineers were investigated. These purposes were addressed in separate studies which are referred to below as experiments. The term experiment was used loosely since only the third study utilized a true experimental design.

Experiment 1

The purpose of Experiment 1 is to answer two questions. What are the academic achievement traits of women engineering students and how do these traits compare to those of male colleagues? What are the attitude and anxiety factors toward math of women engineering students?

Subjects

Data from two groups of subjects were used to address the questions listed above. Both groups were used to address achievement, whereas only the latter group were used to study attitude and anxiety factors toward math. The first group of subjects were 144 women and 150 men who were first semester engineering freshmen at Iowa State University during the fall semester of 1981. This represents all women engineering students and a random sample of 150 men from a population of 971 male engineering students.

The subjects utilized for achievement information as well as information relating to attitude and anxiety factors were 437 new students in engineering who were enrolled in two of the five sections of the Freshmen Orientation class in fall of 1983. For the most part, this group was comprised of first-time freshmen but some transfer students were enrolled. Transfer students were utilized in the study if they were still taking freshmen level mathematics courses.

Procedure

In order to address the question concerning academic achievement, the following variables were selected for analysis: sex, high school rank, ACT-English, ACT-Math, ACT-Social Studies, ACT-Natural Science, ACT-Composite score, math and science courses taken, math placement scores and grades in various math courses. A questionnaire was developed to address the question concerning math anxiety and attitudes. Questions were asked to measure attitude and anxiety factors toward math in order to determine how attitude and anxiety relate to the academic achievement factors mentioned above. In addition, questions asking for some of the academic achievement information that had been obtained with the 1981 group were also included on this questionnaire. This also provided an opportunity to assess the stability of the 1981 data.

The University Committee on the Use of Human Subjects in Research reviewed this study and concluded that the rights of the students being studied by the above questionnaire were adequately protected. Confidentiality of the data was assured.

Materials

A questionnaire (See Appendix - Math Questionnaire) was developed to address the second part of Experiment 1. The first section of the questionnaire was academic achievement data. The academic achievement data were used to ascertain if these academic traits were related to attitude and anxiety factors.

In this section on academic achievement, students were asked to provide math placement test scores received on two of five math placement tests (based on extent of high school background) taken during summer orientation. The five tests were three algebra tests (AA, AB, AC) of increasing difficulty levels, trigonometry and calculus.

Students were also asked to report Math ACT and Composite ACT scores, high school rank, math course currently enrolled in and accurate placement in math course (students may elect not to follow advisor's recommendation). At the end of the semester when grades were available, grade received was added to the data and other academic information was verified from available student records.

Math (beginning algebra, intermediate algebra, advanced algebra, trigonometry, calculus), science (biology, chemistry, physics), and computer science classes taken in high school were also requested. This information was self-reported and not verified by existing student records.

In addition to the descriptive data, part two of the questionnaire was designed to measure attitude and anxiety factors primarily toward math. The attitude factors measured were confidence (ATTCONF), usefulness of math (ATTUSE), attitude of mother (ATTMOTH), attitude of father (ATTFATH), effectance motivation (ATTEFFM), attitude of teachers (ATTTEAC), attitude of math as a male domain (ATTDOM), and attitude toward success (ATTSUCC). The anxiety factors were all grouped under one category (ANXIETY). The items comprising each factor are shown on the sample questionnaire (See Appendix - Math Questionnaire). The questionnaire used was formulated by combining ideas gained from reviewing the Fennema-Sherman Mathematics Attitude Scale (Fennema and Sherman, 1976a), Dutton's Attitude Scale (Dutton, 1954), and MARS, Math

Anxiety Rating Scale (Richardson & Suinn, 1972), and the anxiety scale used by Betz (1978) of Ohio State University. In order to address the issue of content validity, the items were reviewed for reasonableness and accuracy by a panel of faculty.

Data analysis

The SPSSX, Statistical Package for the Social Sciences, was used to analyze the data. The SPSSX Reliability program (Cronbach's coefficent alpha) was used to calculate the reliability of the factors measuring attitude and anxiety. When a factor has high reliability, it is assumed that all of the statements in the questionnaire relating to that factor are measuring the same characteristic. Frequencies for each variable were calculated. The t-tests for statistical significance were calculated for each variable (academic achievement data and anxiety and attitude factors) for males vs. females.

Experiment 2

The purpose of Experiment 2 was to determine the retention rates of men and women engineering students and to determine if they leave engineering for the same reasons.

Subjects

The subjects used to address the question of retention rates were the same subjects used in Experiment 1, Part 1. This group included 144 women and 150 men who were first semester engineering freshmen at Iowa State University during the fall semester of 1981. This group represented all women engineerng students and a random sample of men from a population of 971 male engineering students.

The subjects utilized for the second question (exit interview) were all students (285 males and 30 females) leaving the Department of Freshmen Engineering beginning fall semester, 1984 and until January, 1985. Of the students who left engineering, 90% were Caucasian. All of these students were enrolled in the pre-engineering program at Iowa State University from one to four semesters. After four semesters most students have proceeded into the professional engineering program or are no longer in the engineering college.

Procedure

In order to address the question of retention rates, each student's major area of study was followed for a period of four semesters and the semester in which they left engineering was noted. To address the reasons for leaving engineering, an exit questionnaire (See Appendix -

Engineering Exit Information) was developed to ascertain possible reasons for non-persistence in engineering.

Materials

The Engineering Exit Information Form was developed using ideas, procedures and samples from "Conducting Student Retention Studies" (Elwell, 1984) published by the National Center for Higher Education Management Systems. Guidelines for developing surveys (Borg & Gall, 1979) were also reviewed. In order to address content validity, the form was reviewed for reasonableness and accuracy by a panel of faculty. Realizing that most reasons for non-persistence can be categorized as academic, financial, personal, or campus concerns, statements were developed in these areas that would relate specifically to the engineering sample (See Appendix - Engineering Exit Information). Information regarding cumulative grade point, ACT scores, and high school rank were added to the form from available student records after the student exited engineering.

Data analysis

The SPSSX, Statistical Package for the Social Sciences was used to analyze the data. Frequencies for each variable were calculated. The t-test for statistical significance was calculated for each reason by male vs. female. Mean grade point average on exit, mean high school rank and mean ACT scores for the nonpersisters also were calculated.

Experiment 3

The purpose of the third experiment was to determine the effect of special intervention or support for women in nontraditional academic majors, utilizing an experimental design.

Subjects

The experimental group consisted of women engineers enrolled in a Freshmen Engineering Orientation class that were assigned to sections B, J, and K (Sections meeting on Tuesday and Thursday at 11). These students were pre engineers that were undeclared, pre aerospace, pre industrial, pre industrial operations, pre chemical, pre computer and pre electrical. The control group were pre engineers assigned to sections A, C, D, E, F, G, H, I, and L (Sections meeting on Monday, Wednesday and Friday at 10). These students were pre engineers that were undeclared, pre ceramic, pre engineering science, pre constuction, pre agriculture, pre surveying, pre civil, pre metallurgy, pre nuclear, pre mechanical, pre chemical, pre computer, and pre electrical. Some majors were represented in both the experimental and control group and undeclared engineers were represented in both groups. While subjects were not assigned by any random number method, the two groups were considered as assigned in a random manner for research purposes. Since computer scheduling is a random process in which students are assigned to a section by academic major, and if one section has no available spaces, students are placed in another section, it is assumed that the students in the control and experimental groups were randomly assigned. This procedure was necessary in order to carry on the experiment within the constraints of the current schedule of classes format. Students did not volunteer for the class. Women in the experimental class had a note attached to their schedule that indicated they would be in a special section of Freshmen Engineering 101 for women which would meet in room 145 Sweeney. This separated the group of experimental women from their male peers. The control group of women attended the traditional orientation class with their male colleagues.

The experiment was conducted as designed with 68 women in the experimental group and 97 women in the control group completing the pretest questionnaire. A total of 57 in the experimental group and 37 in the control group completed both the pretest and posttest questionnaires.

Students who completed the pretest only or posttest only were eliminated from consideration in the study. The t-test showed no significant differences existed on the pretest between students who completed the pretest only and those who took the pretest and subsquently completed the posttests. This was true for the experimental and the control group. The reason for so many students not taking the posttest is not fully understood. However, every questionnaire did have a statement attached that included the following statement: "If for any reason you do not wish to fill out this questionnaire, just hand back the blank copy to the instructor by the door at the end of the class period". Perhaps students in the larger control group just didn't bother because they had no interest or involvement in the experiment.

The t-tests showed only one significant difference in the pre scores of the control versus the experimental groups. Since only one difference was noted, the assumption of random assignment to control and experimental group was verified. Commitment to getting a college degree was the only significantly different (.036) item, with the experimental group reporting a mean of 4.96 and the control group a mean of 4.50 on a 5 point Likert scale. Both groups were very committed to getting a college degree.

High school rank approached statistical significance (.052) with the experimental group having a higher high school rank. No statistically significant difference was found for any ACT scores for the two groups. The mean ACT scores for the experimental and control groups were 23.7 and 23.9 for English, 26.9 and 26.3 for Math, 23.8 and 23.9 for Social Studies, 27.6 and 25.5 for Natural Science and 25.7 and 24.9 for the Composite score. These data support the random selection process used to place women into the experimental and control groups.

Procedure

During fall semester, 1984, a support class for women engineers was taught in conjunction with the Freshmen Engineering Orientation (See Appendix - Fr E 101 Women's Section) class. Special sessions were developed to coincide with the first seven sessions of the traditional form of FR E 101 (See Appendix - FR E 101: Orientation And Career Planning). To assess the effect of intervention, a questionnaire was developed (See Appendix - Freshmen Engineering Orientation 101) and used as a pretest and posttest. The questionnaire was designed to measure achievement of course goals.

Materials

The class was developed with the following goals in mind: 1. Provide role models for women engineering students. 2. Provide peer support for women engineering students. 3. Inform women engineering students of opportunities for women in engineering. 4. Provide a "critical mass" of women engineering students. 5. Provide a basis for building confidence and self esteem. 6. Provide students with traditional orientation information relating to University and College policies and procedures.

A questionnaire was developed (See Appendix - Freshmen Engineering Orientation 101) to measure nontraditional field adjustment (NTFA), role model awareness (ROLMOD), confidence in engineering (CONFENG), support of significant others (SUPPOTH), peer support (PEERSUP), commitment and persistence to engineering (COMMPERS), and awareness of opportunities in engineering (OPPENG). The questionnaire was developed by the researcher to meet the needs of this particular study and to coincide with the course objectives. In order, to address content validity, the questionnaire was reviewed by a panel of faculty. Retention rates and cumulative grade point average for the experimental and control groups were recorded on the form at the end of the semester.

Experimental design and data analysis

The experimental design used in this experiment was pretest-posttest control group design. This design involves the following steps: random assignment of subjects to the experimental and control groups, 2. administration of pretest to both groups, 3. administration of the treatment to the experimental group but not to the control group, 4. administration of a posttest to both groups.

The data consisted of pretest means and posttest means for both experimental and control groups on each factor. The statistical method used was the t-test. For all variables, the difference between pretest scores for experimental and control groups was tested for statistical significance. If no significant difference existed on a variable, only posttest scores were used in testing hypotheses.

The SPSSX Reliability program (Cronbach's coefficient alpha) will be used to calculate the reliability of the various statements used to measure each cluster of related items on the questionnaire.

RESULTS

Experiment 1

The purpose of experiment one was to compare academic achievement levels and attitude and anxiety factors toward math of women and men engineering students. Various achievement scores were available for the fall 1981 entering students (n = 150 males and n = 144 females) and for the fall 1983 entering students (n = 382 males and 50 females) who were given the math questionnaire. The math questionnaire was also used to collect information about attitude and anxiety factors toward math.

Academic achievement of students

Male and female engineering students in two separate data sets were compared in terms of high school rank, number of math courses taken in high school, number of science courses taken in high school, ACT scores, grade in first college math course and cumulative grade points. Women entering engineering were hypothesized to be superior to their male colleagues in these various measures of academic achievement. As predicted, high school rank for the women engineering students was significantly higher than the rank of the male students for both sets of data. The mean rank for male students entering fall of 1981 was 18.15 and the mean score for women was 11.05, $\underline{t}(281) = 5.11$, $\underline{p} \leq .000$. For fall of 1983, the means were 17.88 and 7.76 respectively, $\underline{t}(105) = 8.05$, $\underline{p} \leq .000$.

In terms of ACT, comparisons were made for two data sets. One included a breakdown of all ACT scores (fall 1981 data), while the other (fall 1983 data) included only the math and composite ACT score (See Table 1). The hypothesis that women are superior to their male colleagues was supported for some ACT scores and not for others. In neither data set did males and females differ on composite score (1981: $\underline{t}(263) = 1.67$; 1983: $\underline{t}(64) = 1.11$) or on the Math subtest (1981: $\underline{t}(249) = 1.71$; 1983: $\underline{t}(367) = .25$). However, the males and females represented in the 1981 data set did differ on Social Studies, $\underline{t}(263) = 2.21$, $\underline{p} \leq .028$, and English, $\underline{t}(262) = 5.54$, $\underline{p} \leq .000$. No difference was noted in the subtest score for Natural Science, $\underline{t}(263) = .39$.

Thus, while the composite scores indicated no differences, individual scores indicated that women appeared to fit the societal expectation of performing better in Social Studies and English than the males. Even though high school ranks were higher for the women on both of these samples, this difference in ability levels was not reflected in higher ACT math or composite scores. This particular performance measure (ACT) indicated the men and women were

TABLE 1. Comparisons of ACT Scores for Men and Women Engineering Students (1981 and 1983 data sets)

Variable	Statistic	Men	Women
ACT Composite (1981 Data)	Mean	25.10	25.90
	Std. Dev.	3.79	4.05
	n	135.	130.
ACT Composite (1983 Data)	Mean	25.43	26.00
	Std. Dev.	3.96	3.06
	n	326.	44.00
Math ACT (1981 Data)	Mean	27.56	26.56
	Std. Dev.	4.27	5.14
	n	135.00	129.
Math ACT (1983 Data)	Mean	27.65	27.45
	Std. Dev.	4.47	3.86
	n	325.	44.
Social Studies ACT (1981 Data)	Mean	23.16	24.75*
	Std. Dev.	6.00	5.77
	n	135.00	130.00
English ACT (1981 Data)	Mean	20.90	23.63**
	Std. Dev.	4.14	3.86
	n	135.	129.
Natural Science ACT (1981 Data)	Mean	28.21	28.00
	Std. Dev.	4.64	4.00
	n	135.	130.

** $p \leq .01$.
* $p \leq .05$.

generally at the same achievement level on entering the engineering college.

The number of math and science courses taken in high school was obtained from the students entering fall, 1983. Students were asked to check courses they had taken from a list of available math and science classes (See Appendix - Math Questionnaire). The women had taken more science classes (M = 3.38) than the men (M = 3.12), $t(75) = 2.37$, $p \leq .021$. The females also had taken more math classes (M = 5.16) than the males (M = 4.76), $t(77) = 3.14$, $p \leq .002$. However, when analyzing performance measures at the college level, no significant differences were observed. Men (M = 2.06) and women (M = 2.25) were not significantly different in grade in their first college math course as measured on the traditional four point grading scale, $t(407) = 1.03$. Cumulative grade point average after four semesters also indicated no significant differences for the men (M = 2.63) and women (M = 2.56), $t(217) = .97$. The fact that women had more math and science courses in high school appeared to have no relationship to certain performance measures at the college level.

Another performance measure available on entering students was the scores on the math placement tests (See Table 2). Students take two of five exams based on high school math courses completed. The five exams include 20 problems and are of increasing difficulty levels as follows: Algebra A, Algebra B, Algebra C, Trigonometry, and Calculus. No significant differences were noted between the men and women on any of the five tests given (AA: $\underline{t}(11) = .77$, AB: $\underline{t}(115) = 1.03$, AC: $\underline{t}(236) = .36$, TRIG: $\underline{t}(175) = .57$, CA: $\underline{t}(44) = .26$). Thus, the men and women were performing at the same level on these exams even though other measures of high school background such as high school rank and number of math courses completed in high school indicated that the high school preparation of the women exceeded that of the males.

Attitude and anxiety factors

In addition to achievement data, experiment one was designed to measure attitude and anxiety factors towards math. Students participating in this study were asked to respond to a set of statements relating to math confidence and anxiety, using a five point scale (5 = strongly agree, 4 = agree, 3 = uncertain/undecided, 2 = disagree, 1 = strongly disagree). Some of the items were phrased negatively (See Appendix - Math Questionnaire) but these items were recoded to agree with the others.

Attitude toward math was addressd by making statements regarding attitude in eight different areas: confidence in

TABLE 2. Comparison of Average Scores of Men and Women on Math Placement Test Scores. (Total number items = 20)

Variable	Statistic	Men	Women
Algebra A	Mean	9.44	7.0
	Std. Dev.	5.41	4.90
	n	9.	4.
Algebra B	Mean	11.38	12.07
	Std. Dev.	3.73	3.51
	n	63.	54.
Algebra C	Mean	8.03	8.21
	Std. Dev.	3.86	3.67
	n	123.	115.
Trigonometry	Mean	8.30	8.61
	Std. Dev.	3.44	3.78
	n	88.	89.
Calculus	Mean	10.00	9.65
	Std. Dev.	5.26	3.91
	n	20.	26.

one's ability to perform in math (ATTCONF), encouragement and confidence in the student by the mother (ATTMOTH), encouragement and confidence in the student by the father (ATTFATH), the attitude of the student towards success in math (ATTSUCC), the encouragement and opinion of the student's teachers (ATTTEAC), the attitude of the students toward math as a male dominant area (ATTMDOM), the perceived usefulness of math (ATTUSE) and the motivation of the student to work on math problems (ATTEFFM). In each of the eight areas, several statements were made. These statements were then grouped for analysis purposes. Cronbach's α coefficient was utilized to estimate the reliability of each cluster of statements. The reliabilities were found to be .70, .75, .79, .41, .60, .75, .51 and .64 respectively for the eight areas. Since the attitude toward success cluster was not reliable, analyses were performed on individual items.

As can be seen on Table 3, all of the average attitude responses were at or above 3.65. Both means of the responses to the anxiety statements were above 3.5. Based on these positive responses, it appears that the students generally possessed positive attitudes and perhaps some anxiety regarding math.

TABLE 3. Average Scores for Men and Women on Attitude and Anxiety Towards Math Item Clusters

Variable[a]	Statistic	Men	Women
Confidence	Mean	4.10	4.03
	Std. Dev.	.59	.59
	n	364.	49.
Attitude of Mother	Mean	4.03	4.10
	Std. Dev.	.61	.64
	n	354.	49.
Attitude of Father	Mean	4.10	4.18
	Std. Dev.	.66	.61
	n	352.	49.
Attitude toward Success	Mean	4.17	4.43**
	Std. Dev.	.51	.49
	n	344.	49.
Attitude of Teacher	Mean	3.87	4.09**
	Std. Dev.	.55	.58
	n	350.	49.
Male Dominant Field	Mean	4.12	4.72**
	Std. Dev.	.68	.43
	n	359.	49.
Usefulness	Mean	4.49	4.61
	Std. Dev.	.47	.40
	n	363.	49.
Effectance Motivation	Mean	3.65	3.70
	Std. Dev.	.66	.58
	n	359.	49.
Anxiety	Mean	3.62	3.58
	S.D.	.63	.62
	n	357.	49.

[a] Variables Described in Appendix on Math Questionnaire.

** $p \leq .01$.

The hypothesis that men and women do not differ in terms of attitude was not entirely supported as significant differences were found for three of the 8 clusters. Attitude toward success indicated a more positive response by the women, $\underline{t}(391) = 3.33$, $\underline{p} \leq .001$. A breakdown of the attitude toward success items was made due to the low reliability of the items when clustered (See Table 4). Variables included the following: 1. happy to be regarded as an excellent math student, $\underline{t}(428) = 1.53$, 2. being regarded as smart would be great, t (58) = .68 3. would think I was some kind of a grind if I got A's, $\underline{t}(401) = 2.74$ (recoded) 4. would like me less if I were really a good math student, $\underline{t}(83) = 3.89$ (recoded). On the items that showed significant differences (3 and 4), the women believed more strongly than the men that getting A's would not make people think of them as grinds and that people would not think less of them if they were good students.

The attitude of the teachers as perceived by the students was also significantly different for men and women, $\underline{t}(397) = 2.57$, $\underline{p} \leq .010$. Women felt they were encouraged by their teachers more than the males. The third area, the attitude of the students toward math as a male dominant area, also revealed a significant difference, $\underline{t}(406) = 5.99$, $\underline{p} \leq .000$. Although neither male nor female students agreed with statements representing math as a male dominant field, females were more strong in their disagreement than were the males. Attitude toward success, attitude of teachers, and attitude of students toward math as a male dominant field were the three attitude areas that indicated highly significant differences with the more positive response being given by the women in each of the three areas as indicated in Table 3.

On five of the eight attitude factors measured, no significant differences were found for males and females. Both the males and females indicated a high level of encouragement from their mother, $t(401) = .73$, and father, $t(399) = .81$. Confidence levels, $t(411) = .72$ and attitude about the usefulness of math, $t(410) = 1.78$ were also high for both groups. Effectance motivation was an area which related to the student's motivation to view a math problem as a challenge and to enjoy working on a problem until a solution was reached. There was no differences between the sexes on this variable, $t(406) = .50$. Many attitude factors were similar when comparing males to this select group of women who have chosen engineering.

Anxiety was measured by a series of eight statements (see Appendix - Math Questionnaire). These statements referred to feelings of anxiety the students possess

TABLE 4. Average Scores for Men and Women on Attitude Toward Success Variables

Variable[a]	Statistic	Men	Women
1	Mean	4.42	4.58
	Std. Dev.	.66	.64
	n	380.	50.
2	Mean	4.21	4.30
	Std. Dev.	.75	.93
	n	377.	50.
3**	Mean	3.64	4.10
	Std. Dev.	1.10	1.23
	n	354.	49.
4**	Mean	4.37	4.71
	Std. Dev.	.82	.54
	n	352.	49.

[a] Variables include the following: 1. It would make me happy to be recognized as an excellent student in mathematics. 2. Being regarded as smart in math would be a great thing. 3. People would think I was some kind of a grind if I got A's in math. (recoded) 4. It would make people like me less if I were a really good math student. (recoded) See Math Questionnaire in Appendix.

** $\underline{p} \leq .01$

regarding taking major math tests, taking smaller math quizzes, asking questions in class, doing homework, and walking in a college math class for the first time. These statements were grouped for analysis purposes and indicated a reliability coefficient of .78 using Cronbach's α reliability coefficient.

As predicted, anxiety factors showed no differences by sex, $\underline{t}(404) = .42$, but the average score for this factor was noticeably lower than any of the attitude factors measured (See Table 3). These statements had an average score just beyond the uncertain/undecided range for both sexes. While frequency distributions indicated a spread of scores over the possible range of one to five, a small percentage (5.4) were definitely anxious (mean scores of 2.5 or less) and approximately half of the students (55.7 %) reported not possessing feelings of anxiety (mean scores of more than 3.5) when asked to express feelings toward math. However, 38.9% of the average anxiety scores were in the uncertain/undecided range (2.51 to 3.50). Thus, anxiety toward math may be a problem experienced by many students.

Some additional questions were included to help clarify the high school experience. High school background items measured characteristics of the high school experience regarding math homework, courses, and teachers. Women showed a more positive response toward their high school experience with mean scores of 4.21 and 4.39 for the men and women, respectively, $t(405) = 1.98$, $p \le .049$. Statements regarding competency of high school math teachers, having math homework in high school and taking advanced math classes in high school showed that women in engineering may have experienced a more favorable high school experience than the males.

Experiment 2

Retention study - four semesters

The question of retention was addressed by following each student's major area of study for a period of four semesters. The sample used was part of the male population (n = 150) and all of the female population (n = 144) for fall semester, 1981. Students were all in engineering at the beginning of the study (fall, 1981). During each of the following four semesters, the students were observed and categorized as still being in engineering or not being in engineering.

The Chi Square test of significance was utilized based on a comparison between the observed cell frequencies of a crosstabulation with the frequencies that would be expected if sex was not a factor in retention. Although sex was hypothesized not to be a factor, sex was found to be related to the curriculum the students were in with more female students leaving engineering. As shown in Figure 2, more women than men were found to leave the College of Engineering each semester, however, the difference was significant only for semester two and three (for the four semesters: $X^2(1, n=294) = 3.13$ $p \leq .076$, $X^2(1, n=294) = 4.32$, $p \leq .037$, $X^2(1, n=294) = 3.82$, $p \leq .050$; $X^2(1, n=294) = 1.97$ $p \leq .16$). The numbers collected are cumulative with the percentage listed as not in engineering at the end of each semester reflected in the percentage for successive semesters. Thus, women appeared to be leaving engineering earlier in their academic career. At the end of semester 3, half of the women had already left, whereas only 38% of the men had left. However, at the end of semester 4, no significant difference in the number of men and women remaining in engineering was indicated.

Engineering exit information

The engineering exit survey was given to all students leaving the pre-engineering program. Reasons for leaving and information about marital status, working status, semesters in engineering and academic information were collected at the time of exit.

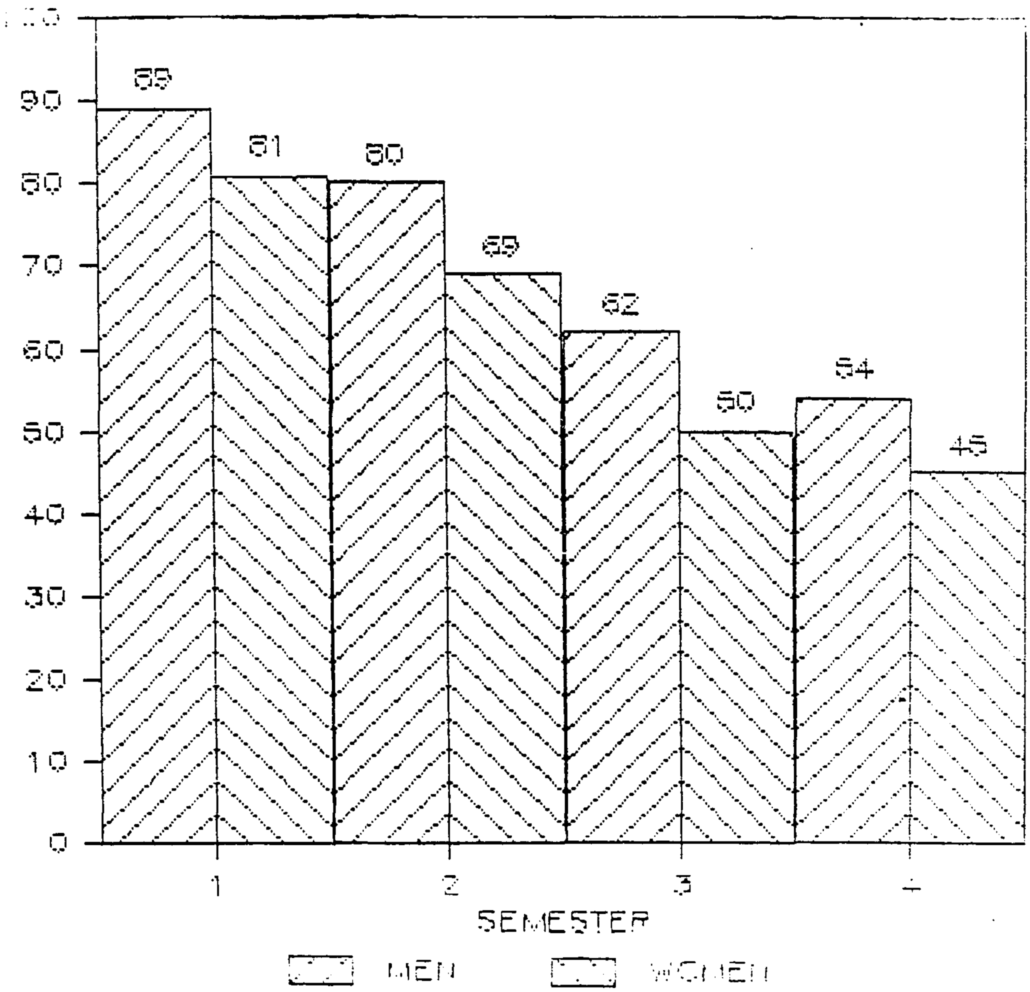

FIGURE 2. Percent of Men and Women Engineering Students Who Remained in Engineering for Four Semesters

<u>General exit information</u> Students were asked their future plans as they left (See Table 5). Statistical analysis of the data was difficult since with only 30 females, any attempt to perform Chi Square yielded too many cells with an expected frequency of less than five.

Therefore, the data are presented in the form of numbers and percentages of male/female.

The largest discrepancy between males and females appears to be in transferring to another college at ISU. On leaving engineering, 86.7% of the females choose another major while only 61.8% of the males choose another major. Both males and females choose the College of Sciences and Humanities more frequently than the other colleges, but the women are choosing that college at twice the rate of their male colleagues. Other colleges (Agriculture, Design, Home Economics) appear to be about equal with perhaps Education attracting more women and Business attracting more males.

Another noticeable difference was in the category on the form marked "other". Without exception, this category was comprised of students who completed the preregistration process during fall semester and were expected to return spring semester but didn't. This group was all male (53 or 18.6% of the exiting male group) with no women preregistering and failing to return.

Other categories appear to be about the same (withdraw, transfer elsewhere) for males and females. However, more males (13%) were academically dismissed than females (6.7%).

As mentioned earlier, statistical analysis of these data with a sample of only 30 females was difficult. For

TABLE 5. Percent of Students Leaving Engineering and Reasons for Exit

Reason for Exit[a]		Males (n)	Percent Males	Females (n)	Percent Females
Withdraw		18	6.3	1	3.3
Transfer at ISU		176	61.8	26	86.7
College Transferred to	AG	9	3.2	2	6.7
	BUS	48	16.8	3	10.0
	DES	20	7.0	1	3.3
	ED	31	10.9	5	16.7
	HE	4	1.4	1	3.3
	S&H	64	22.5	14	46.7
		176	61.8	26	86.7
Transfer Elsewhere		1	.4	1	3.3
Academically Dismissed		37	12.9	2	6.7
(Did not return after pre-registering)		53	18.6	0	0
		285	100%	30	100%

[a] Reasons Described in Appendix on Engineering Exit Information Survey.

this reason, some regrouping of data was done in order for statistical analysis to be completed. Chi Square test of significance was calculated by looking at each variable and grouping the others in one category for the purpose of comparing the males and females. Students who withdraw were compared to students who leave for other reasons with no significant difference noted, $X^2(1, n = 315) = .058$ for the males and females. No significant differences were noted between males and females for academic dismissal from school compared to leaving for all other reasons $X^2(1, n = 315) = .49$. However, two of the reasons for leaving, not completing registration and changing majors within the university, showed differences for the sexes. When using the grouping of changing majors or leaving for other reasons, women left to change majors more frequently than males, $X^2(1, n = 315) = 6.347$, $p \leq .025$. More men were completing the preregistration process and then not returning to school, $X^2(1, n = 315) = 5.447$, $p \leq .025$.

As predicted, women in engineering are transferring to other majors more frequently than males. The phenomenon of only male students not completing registration when they had preregistered was not predicted. Also, since this unique group of women was hypothesized to be comprised of superior students, it was also hypothesized that they would not leave due to academic difficulties as frequently as the males. However, there appears to be no relationship between sex and being academically dropped.

Other general information collected included hours per week working, semesters in engineering and various academic information (See Table 6). No significant differences between men and women were found for hours per week working ($t(213) = .28$), ACT scores (Composite ACT, $t(235) = .39$, English ACT, $t(232) = 1.75$, Math ACT, $t(232) = .71$, Social Studies ACT, $t(232) = 1.03$, Natural Science ACT, $t(232) = .47$) and cumulative grade point average on exit $t(209) = .10$. Highly significant differences were found for the semesters in engineering, $t(45) = 2.83$ $p \leq .01$, and high school rank, $t(37) = 4.09$ $p \leq .00$ of students leaving engineering, with women on the average performing better in high school, but remaining in engineering for a shorter period of time than men.

From this general retention data, some interesting information was noted. Apparently, women are leaving engineering at an earlier point in their academic careers. As would be expected, the women exiting have higher high school rank than the men since they also had higher high school rank on entry. No married women left engineering while 6.8% of the males leaving were married. Cumulative

TABLE 6. Retention Study - Comparison of Men and Women Leaving Engineering

Variable	Men			Women		
	Mean	Std. Dev.	n	Mean	Std. Dev.	n
Hours Per week working	3.22	7.82	189	2.77	7.02	26
Semesters in Engineering**	1.91	1.23	224	1.44	.75	27
High School Rank**	21.51	13.3	241	13.60	8.65	25
Composite ACT	25.22	3.41	216	25.52	3.37	21
English ACT	21.44	3.92	213	23.00	3.63	21
Math ACT	26.55	3.91	213	25.90	5.03	21
Social Studies ACT	23.95	5.00	213	25.14	5.56	21
Natural Science ACT	28.02	4.30	212	27.57	3.41	21
Cumulative Grade Point on Exit	1.94	.68	197	1.92	.75	14

[a] See Appendix for Engineering Exit Information Survey.

** $p \leq .01$

grade point was low on exit for members of both groups who left after the first semester was completed, so academic failure was a factor for some students leaving although no difference was shown for males and females.

Academic reasons A series of questions designed to measure academic reasons for leaving engineering were asked and the responses were measured on a Likert scale (1 = not important at all to 5 = extremely important). Retention of males and females was hypothesized to be similar but it was expected that they would leave engineering for different reasons. This was found to be true for some of the academic reasons. Highly significant differences were found between males and females for the following statements: "I had a change in career plans (reason A.), $t(214) = 2.72$ $p \leq .001$, "Courses I wanted were not available (reason C.), $t(58) = 3.06$ $p \leq .003$, and "I did well in engineering, I just didn't like it" (reason P.), $t(200) = 2.81$ $p \leq .005$.

No significant differences were noted for other academic reasons. Reasons rated as relatively high (see Table 7) with no differences shown for the sexes were the statements: "I am dissatisfied with my academic performance" and "the course work was not what I wanted". Reasons rated low or not important and showing no difference for the sexes were the following statements: " I am dissatisfied with the quality of teaching", "I am dissatisfied with the learning environment", "Tutoring was not available", "I was uncomfortable around the instructors", "I usually had no one to study with" and "Academic advising was not adequate". All these statements had means less than 2.0 and on the average were not considered reasons for leaving by the students.

Financial reasons   Three financial reasons for leaving were given as a choice (see Table 8). Although all of the financial reasons had mean scores between 1.04 and 1.50 (not important range), a highly significant difference between males and females was found for two of these reasons. Males more frequently cited that they did not have enough money to continue, $t(162) = 4.43$, $p \le .000$ and could not earn money while enrolled, $t(50) = 2.76$, $p \le .008$. Being able to obtain financial aid showed no significant difference for the two groups.

Campus concerns   Campus concerns were not a major reason for leaving engineering for the students (see Table 9). The mean ratings for all items were between 1 and 2, indicating those reasons were not important. "I wanted to participate in more cultural and social events", was the only reason (reason B.) that came across as perhaps having any importance and it had a similar rating for both sexes.

TABLE 7. Academic Reasons for Leaving Engineering

Reason[a]	Men Mean	Men Std. Dev.	Men n	Women Mean	Women Std. Dev.	Women n
A**	3.79	1.28	189	4.48	.94	27
B	2.45	1.14	187	2.30	1.17	27
C**	1.48	0.86	186	1.15	0.46	27
D	3.26	1.38	188	2.96	1.40	27
E	1.97	1.09	188	1.85	1.32	27
F	1.88	1.05	186	1.65	1.20	26
G	3.23	1.33	186	3.68	1.49	25
H	2.77	1.43	187	2.46	1.56	26
I	2.45	1.32	187	2.77	1.63	26
J	2.35	1.15	186	2.19	1.27	26
K	1.31	0.62	186	1.23	0.71	26
L	1.65	0.94	186	1.88	1.45	26
M	1.61	1.02	186	1.85	1.32	26
N	1.44	0.86	178	1.46	0.86	26
O	2.17	1.15	179	2.00	1.36	26
P*	2.37	1.20	177	3.12	1.56	25

[a] Reasons Described in Appendix on Engineering Exit Information Survey.

** $p \leq .01$.
* $p \leq .05$.

TABLE 8. Financial Reason for Leaving Engineering

Reasons[a]	Men			Women		
	Mean	Std. Dev.	n	Mean	Std. Dev.	n
A**	1.36	0.81	176	1.04	0.20	26
B	1.40	0.88	176	1.23	0.86	26
C**	1.50	1.02	177	1.12	0.59	26

[a] Reasons Described in Appendix on Engineering Exit Information Survey.

** $\underline{p} \leq .01$.

TABLE 9. Campus Concerns: Reason for Leaving Engineering

Reason[a]	Men			Women		
	Mean	Std. Dev.	n	Mean	Std. Dev.	n
A	1.49	1.01	176	1.50	1.24	26
B	1.91	1.11	176	1.96	1.08	26
C	1.20	0.48	176	1.12	0.43	26
D	1.51	0.96	176	1.35	1.02	26

[a] Reasons Described in Appendix on Engineering Exit Information Survey.

Personal reasons On the section of reasons dealing with personal concerns (see Table 10), no significant differences for men and women were found. When observing the means for these reasons, every one was higher for the women. While the differences were not significant at the .05 level, perhaps an indication exists that these variables were important. In addition, if a larger sample of women could have been utilized, some of the observed differences may have been statistically significant.

Summary of exit survey When women leave engineering, most are changing majors while men leave for a variety of reasons. Both men and women who choose other majors are most likely to choose majors in the Sciences and Humanities college, but women choose that college twice as frequently as men. Business is the second choice of the men, while Education is the second choice for women.

Women are leaving engineering earlier in their academic careers and more women say they leave because they have a change in their career plans. Since they reported that they "just didn't like engineering", leaving to choose a different career is expected.

Neither group reportd that financial reasons were important to their decision to leave engineering, although men stated this as a reason for leaving more frequently than

TABLE 10. Personal Reasons for Leaving Engineering

Reason[a]	Men Mean	Men Std. Dev.	Men n	Women Mean	Women Std. Dev.	Women n
A	1.08	0.38	172	1.38	0.90	26
B	1.57	0.98	174	1.58	1.07	26
C	1.18	0.56	174	1.42	1.07	26
D	1.43	0.79	174	1.54	1.14	26
E	1.38	0.84	174	1.58	0.95	26
F	1.37	0.83	173	1.81	1.36	26
G	1.10	0.36	173	1.19	0.63	26
H	1.40	0.78	172	1.54	1.17	26

[a] Reasons Described in Appendix on Engineering Exit Information Survey.

women. Perhaps due to socio/cultural factors, their perceived need to have money is greater.

The college experience, housing, recreational programs, cultural events and social events appear to be of little concern to engineering students. They report that these reasons had little or no impact on the decision to leave. Personal reasons may have had some impact on the decision to leave, but this was not revealed in the current data.

Experiment 3

Course objectives

During fall semester, 1984, a support class for women engineers was taught. To assess the effect of this orientation class on women, a questionnaire was developed (See Appendix - Freshmen Engineering Orientation 101) and used as a pretest and posttest. The questionnaire was designed to measure achievement of course objectives and various other factors deemed important for success of women in engineering.

Nontraditional field adjustment Nontraditional field adjustment was measured by a series of questions that addressed the appropriateness of women studying engineering, the feelings associated with being in all male classes, the sacrifices professional women make in their personal lives and the attitude they and others in their lives possessed regarding engineering as a career (See Table 11). No significant differences were found when comparing post experimental and post control groups on any of the variables ($t(92) = .83$, $t(92) = 1.05$, $t(84) = .61$, $t(84) = .45$, $t(84) = .57$ for the five variables respectively). In fact, on many of the variables the rating was so high on the pretest that it was not possible for the experimental group to achieve posttest scores that were higher than the control group.

Other interesting information was noted (See Table 11, Variable 3). While both groups were quite undecided on the pretest when asked to agree or disagree with the statement, "Women who become engineers will make more sacrifices in their personal and social lives than women in other professions", a significant increase in agreement was noticed on the posttest. (Since this was a negatively worded item on the survey, responses were recoded for analysis. Thus, although the mean (recoded) responses for this item in Table 11 appear to indicate increased disagreement on the posttest, the reverse is actually the case.) Both control, $t(50) = 3.89$, $p \leq .001$, and experimental groups, $t(26) = 2.37$, $p \leq .000$, indicated that women would make more sacrifices when posttested compared to their pretest opinion. Perhaps after learning more about

TABLE 11. Comparisons of Nontraditional Field Adjustment for Experimental and Control Women's Class

Variable[a]		Pretest Means	Std. Dev.	n	Posttest Means	Std. Dev.	n
1.	Exp.	4.77	.63	57	4.88	.33	57
	Cont.	4.91	.28	37	4.89	.32	37
2.	Exp.	3.84	.98	57	3.89	.96	57
	Cont.	4.05	1.10	37	4.11	.97	37
3.	Exp.	3.19	1.01	52	2.59	1.04	54
	Cont.	3.31	1.17	29	2.81	.97	32
4.	Exp.	4.52	.87	52	4.48	.89	54
	Cont.	4.43	1.03	28	4.56	.67	32
5.	Exp.	4.25	.71	52	3.68	.97	54
	Cont.	4.25	.93	28	3.66	.91	32

[a] Variables include the following: 1. Appropriateness of women studying engineering. 2. Feeling uncomfortable in an all male class. 3. Making more sacrifices in social and personal life. 4. Peculiarity of women who enjoy engineering. 5. Speaking up in class if discriminated against due to sex. See Freshman Engineering Orientation 101 Survey in Appendix.

the engineering profession via an orientation class, the students concluded that more sacrifices than needed in any profession would have to be made to be a successful engineer and this factor was irrespective of whether the student learned of the profession from women (experimental class) or men (control class).

Role models   Providing role models for women engineers was an objective of the experimental course (See Table 12). When comparing the experimental and control class, a greater awareness of women faculty was developed in the experimental group, $t(87) = 3.42$, $p \leq .001$, and students in this group knew more women faculty members, $t(71) = 1.93$, $p \leq .05$. The experimental group also were aware of more successful women engineers from industry, $t(87) = 3.86$, $p \leq .000$. When asked how many successful women engineers they were aware of, the experimental group said they knew approximately four times as many as the control group, $t(53) = 3.71$, $p \leq .001$.

Women in the experimental group were also more aware, $t(43) = 4.05$, $p \leq .000$, of other successful women engineering students, although the numbers they reported being aware of were not significantly different, $t(67) = .92$. The average number of women engineers reported in Table 12 does not include the answer of two respondents in

TABLE 12. A Comparison of Role Model Awareness for Experimental and Control Women's Class

Variable[a]		Pretest Means	Std. Dev.	n	Posttest Means	Std. Dev.	n	How Many	Std. Dev.	n
1.	E	2.56	1.23	53	3.47	1.25	55	2.58	2.45	53
	C	2.58	1.05	34	2.59**	1.08	34	1.35*	2.39	20
2.	E	2.74	1.39	53	3.73	1.24	55	4.19	3.93	52
	C	3.03	1.19	34	2.71**	1.17	34	1.32**	2.41	19
3.	E	2.77	1.46	48	4.28	.74	54	5.7	5.10	49
	C	3.04	1.14	28	3.25**	1.32	32	4.4	5.29	20

[a] Variables include the following: 1. Aware of women faculty. 2. Aware of women engineers from industry. 3. Aware of women engineering students. See Freshman Engineering Orientation 101 Survey in Appendix.

* $p \leq .05$.
** $p \leq .01$.

the experimental group who gave 100 as an answer. The fact that the reported averages were not significant was probably due to the large variability of answers.

These awareness of role model items formed an internally consistent cluster of items ($\alpha = .80$). Students who were aware of women faculty were also aware of women students and women from industry in engineering.

Confidence in engineering Confidence in engineering was addressed by questions relating to confidence or ability to do advanced work and to receive the degree in engineering (See Table 13). Grades anticipated or expected in engineering were also measured. No significant differences were found on any of these factors between the experimental and control groups ($t(92) = .81$, $t(84) = .75$, $t(83) = .43$ for the three variables, respectively). The scores indicated that both experimental and control subjects were very confident on the pretest and the possibility of noting that the experimental group improved more than the control was not likely.

Support of others Support of mother, father, high school teachers and college instructors was measured in this section (See Table 14). No significant differences were found in the experimental and control groups on the posttest ($t(91) = .15$, $t(84) = .78$, $t(84) = 1.44$, $t(84) = .48$ for the

TABLE 13. Comparisons of Confidence Variables in Engineering for Experimental and Control Women's Class

Variable[a]		Pretest Means	Std. Dev.	n	Posttest Means	Std. Dev.	n
1.	E	4.00	.63	57	3.96	.73	57
	C	4.16	.60	37	4.08	.60	37
2.	E	4.25	.65	52	4.11	.86	54
	C	4.21	.82	29	4.25	.76	32
3.	E	1.92	.84	52	2.32	1.11	53
	C	1.93	.90	28	2.21	.98	32

[a] Variables include the following: 1. Sure I can do advanced work. 2. Confident I will be a practicing engineering someday. 3. Disappointed if B average cannot be maintained. See Freshman Engineering Orientation 101 Survey in Appendix.

four variables, respectively). The expectation that perceptions would change on these items for the experimental group was probably unrealistic since the support group took place during a short period of time and students probably did not have an opportunity to be with their mother, father, etc. These means probably indicate the level of support these women perceive they have from significant others.

Peer support Peer support was addressed by measuring support from the following sources: women engineering students, friends in engineering, women friends to study with in technical subjects, male friends to study with in technical subjects, and belonging to a professional student organization.

As seen in Table 15, women in the special class were more aware of other successful women engineering students $t(43) = 4.05$, $p \leq .000$. When asked to state how many women engineering students they were aware of, the experimental group reported more than the control, although the variability in answers was too great to permit the difference to be statistically significant.

The control women reported more friends who are engineering students, $t(81) = .83$ and more male friends to study with, $t(82) = .98$, but they had fewer women friends to study with, $t(81) = 1.49$ and were less likely to join a

TABLE 14. Comparisons of Support of Others for Experimental and Control Women's Class

Variable[a]		Pretest Means	Std. Dev.	n	Posttest Means	Std. Dev.	n
Mother	E	3.35	1.19	57	3.51	1.20	57
	C	3.65	1.18	37	3.47	1.16	36
Father	E	3.75	1.27	52	3.98	1.09	54
	C	3.76	1.30	29	3.78	1.26	32
High School	E	4.23	1.08	52	4.19	.97	54
Teacher	C	4.18	.77	28	3.84	1.19	32
College	E	3.18	.95	51	3.26	.92	54
Instructor	C	3.00	.94	28	3.16	1.05	32

[a] See Freshman Engineering Orientation 101 Survey in Appendix.

TABLE 15. A Comparison of Peer Support for Experimental and Control Women's Class

Variable[a]		Pretest Means	Std. Dev.	n	Posttest Means	Std. Dev.	n	How Many	Std. Dev.	n
1.	E	2.77	1.46	48	4.28	.74	54	5.7	5.10	49
	C	3.04	1.14	28	3.25**	1.32	32	4.5	5.30	20
2.	E	3.08	1.58	50	3.55	1.33	51	5.6	5.90	48
	C	3.22	1.28	27	3.78	1.07	32	7.0	10.04	25
3.	E	2.78	1.37	49	3.40	1.29	52	1.9	1.46	46
	C	3.35	1.36	26	2.97	1.30	31	2.8	3.35	21
4.	E	2.96	1.38	49	3.38	1.44	53	2.9	3.09	45
	C	3.46	1.33	26	3.68	1.17	31	3.5	2.69	24
5.	E	3.44	.92	52	4.20	1.12	54			
	C	3.57	1.03	28	3.81	1.03	32			

[a] Variables include the following: 1. Awareness of women engineering students. 2. Awareness of friends who are engineering students. 3. Number of women friends with whom to study. 4. Number of male friends with whom to study. 5. Likelihood of joining professional organization. See Freshman Engineering Orientation 101 Survey in Appendix.

* $p \leq .05$.
** $p \leq .01$.

professional organization, $t(84) = 1.61$. None of the differences on these items was statistically significant. And while on a Likert scale, the experimental women gave a stronger response than the control women to having women friends to study with, when asked the actual number, the experimental group reported fewer than the control.

Commitment or persistence in engineering Commitment or persistence in engineering was addressed by measuring commitment to getting a degree, being an engineer, and staying in engineering even if grades are low (See Table 16). None of the differences on the five variables was statistically significant ($t(84) = .61$, $t(84) = .44$, $t(84) = .60$, $t(84) = .01$, $t(84) = .13$ for the five variables, respectively). Both the experimental and control groups showed a high level of commitment or persistence during pretesting and posttesting. On a Likert scale, all of the means but one were between 4.0 and 5.0. This indicated most of the women agreed or strongly agreed with the statements relating to persistence.

One item was noticeably lower on commitment and persistence. Students were quite undecided (3 = undecided) about continuing in engineering if they could only maintain a C grade point average. These scores indicated that the women in engineering were undecided about engineering if they could not experience a high level of academic success.

TABLE 16. Comparisons of Commitment or Persistence in Engineering for Experimental and Control Women's Class

Variable[a]		Pretest Means	Std. Dev.	n	Posttest Means	Std. Dev.	n
1.	E	4.96	.19	52	4.87	.39	54
	C	4.59	.91	29	4.81	.47	32
2.	E	4.46	.58	52	4.26	.92	54
	C	4.21	1.01	29	4.34	.79	32
3.	E	4.06	.80	52	3.87	.99	54
	C	4.00	1.09	28	4.00	.95	32
4.	E	4.23	.70	52	4.19	.89	54
	C	4.25	.93	28	4.19	.86	32
5.	E	3.38	1.01	52	3.69	.97	54
	C	3.61	.96	28	3.66	.97	32

[a] Variables include the following: 1. Committed to getting a college degree. 2. Committed to getting an engineering degree. 3. Very important for me to succeed in engineering. 4. Very important to be an engineer someday. 5. Will continue in engineering even with a C average. See Freshman Engineering Orientation 101 Survey in Appendix.

Opportunities in engineering   Women in the control and experimental groups were generally very positive (See Table 17) in their belief that opportunities exist for women in engineering. Due to the high positive answers in the pretest (all above 4.31 on a 5 point scale), room for statistically significant improvement did not exist.

In the control group, the average response to the question about whether engineering offers many opportunities for women declined on the posttest. Hence, there was a highly significant difference between the experimental and control women for this item on the posttest, $t(92) = 3.21$, $p \leq .002$. Perhaps these women did not recognize that opportunities for women exist in engineering since they were only exposed to engineering via male role models. No significant differences were noted in the average responses to the questions about women engineers doing interesting work, $t(84) = .87$, and engineering offering many opportunities to advance professionally, $t(84) = .42$.

Academic information

At the end of the first semester at Iowa State University, cumulative grade point average was calculated for the experimental and control groups (2.73 and 2.53, respectively). This difference was not statistically significant, $t(92) = 1.18$.

TABLE 17. A Comparison of Opportunities in Engineering for Experimental and Control Women's Class

Variable[a]		Pretest Means	Std. Dev.	n	Posttest Means	Std. Dev.	n
Engineering Offers many Opportunities For women	E	4.74	.48	57	4.77	.46	57
	C	4.62	.55	37	4.43**	.55	37
Women Engineers do Interesting And rewarding Work	E	4.50	.58	52	4.55	.63	54
	C	4.55	.51	29	4.44	.56	32
Engineering Offers many Opportunities To advance Professionally	E	4.31	.76	51	4.52	.50	54
	C	4.48	.74	29	4.47	.57	32

[a] See Freshman Engineering Orientation 101 Survey in Appendix.

** $p \leq .01$.

Retention

Out of all the women who started in the experiment (took the pretest), 85 out of 95 of the control women and 64 out 68 of the experimental women were still in engineering at the end of first semester. Although not statistically significant, $X^2(1, n = 163) = .57$, a difference of 5% was noted between the experimental and control group with more of the experimental group remaining in engineering.

Of the experimental women who left engineering, three transferred to the Home Economics College and one to the Education College. Of the control women who left engineering, one transferred to Agriculture, one to Business, one to Design, five to Home Economics and two left the university.

Retention of this experimental group of women was next compared to the retention of all women enrolled fall 1981. All of the women for fall 1981 were in an orientation class with male students and no attempt was made to do special programs for these women. Thus, in a sense this group represents another control group, one removed in time from the experiment and not subject to the possibility of any "spillover" effect from the treatment. Retention statistics indicate that at the end of the first semester, 19.4% (28 out of 144) were no longer in engineering. When comparing the fall 1981 women to the experimental class, women were retained at a higher rate at the end of first semester in the experimental group, $X^2(1, N = 212) = 5.6$, $p \leq .025$. When comparing the control group of women to the fall 1981 women, no difference was noted, $X^2(1, n = 239) = 1.87$. These women had similar retention rates as expected since no special treatment was given to either group. These results should be interpreted with caution due to the post hoc nature of this analysis.

Student comments

A course evaluation was distributed during the last class period. The students in the experimental group were encouraged to make comments regarding the value of programs presented, suggestions for programs not included, and the positive and negative aspects of participating in a women's section if given the choice.

Of all the presentations given, the ones the students perceived to be of most value were the two in which women engineering students were on the program. One of these programs had junior and senior students discuss their summer work intern programs and co-operative education programs (work programs of longer duration). How they got their jobs and what they did at work were discussed with an opportunity provided for the freshmen to ask questions. The other popular program was titled "What Engineering is Really Like". This was an informal discussion with women students enrolled in each curriculum represented in the class. These presentations were more popular than presentations given by women engineers from industry.

Positive comments about the class included the following from different women: "Helped to see that women really can make it through engineering"; "Class lets you know that people are behind you 100% and really want you to succeed"; "Provided moral support"; "Boosts self-confidence"; "Made me feel more at home and less uncomfortable"; "It did relate engineering to women through a women's point of view and taking into account things like the desire to have a family".

Negative comments about the class, while much fewer in number, included the following: "No males in class tends to isolate us even more"; "I feel like if I don't stay in engineering now I'm copping out since there is so much emphasis on women sticking it out"; The talk on two career families was most annoying. Would they give that talk to a male majority?"; "We need to get used to being a minority, forced to interact and prove we are equals early."

When asked their preference, the majority (58) of the women would choose a women's orientation section if given the choice, three were undecided and three would choose the traditional class.

Summary of experiment 3 results

For many of the variables measured there was no significant difference between experimental and control groups at the end of the experiment. Much of this was due to the unexpected high ratings on the pretest. This group of women came to Iowa State adjusted to their nontraditional career choice, with a high level of confidence and very committed to being a persister in engineering. Due to these high initial ratings, there was little room for improvement.

The area in which the experimental and control groups differed the most was in role models. The course definitely made the students more aware of other women students, faculty, and professionals in engineering. Informal evaluations of the course showed a very positive response to the special class. Individual specific benefits from the class may be difficult to measure but there was a general feeling of positivism or value in being in the class.

CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to investigate variables which may be related to success for women students in engineering. This purpose was addressed by research in the areas of academic achievement, attitude and anxiety; retention; and the effect of a support class.

Academic Achievement, Attitude, and Anxiety

This study hypothesized that women would be superior to males in the area of academic achievement and would not differ from their male colleagues in attitude and anxiety toward math. In all the data analyzed for academic achievement, the females either ranked higher or were not statistically different. Academically, females were higher in high school rank, number of math courses taken in high school, number of science courses taken in high school, English ACT score and Social Studies ACT score. There were no differences on performance measures on entering college or during the first semester. Neither were there differences on math placement test scores, grades in the first college math class and cumulative grade point average. While one might expect these performance measures to be higher due to the superior academic achievement prior to entering college, this expectation was not realized.

Perhaps, the transition from high school to college was more difficult for women in this study. This appears to mark a point at which their academic achievement is no longer superior to their male peers. This transition point in the academic career of women may be a time when special help is needed.

In regard to attitude toward math, some significant differences existed, with women indicating a more positive attitude than the men. Women believed they were encouraged more by their teachers and women also had a more positive attitude toward success. This supports the literature cited in the review, that significant others can be a very positive influence in choosing a nontraditional career such as engineering. Women engineering students also did not view math as a male domain area. Their high school teachers instilling a positive attitude may be connected to this viewpoint. By males more than females viewing math as a male domain, subtle social pressures may exist at the college level that did not exist for these women at the high school level. They may start to doubt their choice for the first time when they encounter males with this attitude at the collegiate level. The females who were subjected to this attitude at the high school level may have decided against a math-oriented curriculum while in high school.

Thus, for many women, this attitude may be encountered for the first time at college. Women in engineering also showed a more positive response to their high school experiences in general. This positive high school math experience may be the reason these women were in engineering. High school experiences, academic achievement, and attitude development appear to be important factors in selection of a nontraditional field for this select group of women.

Anxiety factors appear to be similar for men and women in engineering and the average scores for both groups were just beyond the uncertain/undecided range. Although the majority reported no anxiety toward math, many definitely considered themselves anxious or were uncertain about their feelings. Thus anxiety may be an academic problem for them. Additional help may be needed for many students to reduce anxiety feelings toward math.

Retention

The question of retention was addressed by studying retention rates and by analyzing exit information to ascertain reasons for leaving engineering. In fall 1981 retention data, women were leaving engineering at a higher rate than males. When making comparisons for the first four semesters of enrollment, significant differences existed for some semesters (semester 2 and 3) and did not exist for others (semester 1 and 4). Thus, it appears that women are leaving engineering at a similar or slightly higher rate than males. The women leaving had higher high school ranks than the non-retained males. They also had fewer semesters in engineering. Thus, even though these women were superior in academic achievement on entry, they were less likely to stay in engineering.

Due to superior academic achievement on entry, it was hypothesized that women would not leave due to academic difficulties as frequently as the males. However, findings indicated that there were no significant differences for number academically dismissed or cumulative grade point on exit. Once again, the academic advantage seems to disappear for the women once they are in college.

Women left engineering more frequently because they had a change in career plans and reported that "I did well, I just didn't like it". Perhaps some of these subtle attitude factors mentioned earlier influenced this. Reasons such as quality of teaching, advising, and tutoring services appeared to have no effect on the decision to exit.

Financial reasons were more of a factor for males leaving than females although this factor was low for all students. This may be due to a larger percentage of the males being married students. Campus concerns were not a major reason for leaving for any of the students. Personal reasons is a variable that may need more study. While no significant differences were noted, the means for these reasons were higher for the females on every reason.

In summary, the majority of women choose another major when they exited engineering while males leave for a variety of reasons. Upon entry these women chose a nontraditional major, assuming they would have a future career in engineering. Early in their academic career, they decided to change to another major because they "don't like it" and "have a change in career plans". More research needs to be done to ascertain the reasons for not liking engineering and the reasons why more women change career plans than men. Women also made this decision to leave earlier than the males.

Support Classes

Finally, a support class for women in engineering was evaluated. The retention rate for women in the support class indicated there may be some value in this type of intervention. A difference of 5% was noted between the experimental and control class with more of the experimental group remaining in engineering (not statistically significant). However, a significant difference was noted in a post hoc analysis comparing retention in the support class to that of the women students from the fall of 1981. Thus, the support class may have had a positive effect on retention rates even after only one semester.

Other benefits of the class may result in improved retention rates that are not visible after one semester. The fact that these women have more role models, more peer support, and are more aware of opportunities for women in engineering may result in benefits for this group of women for many years beyond the short period of this study.

A pattern that may represent a stereotypic bias was evident in the responses of some members of the support group during collection of data. Many women did not report being aware of as many women engineers as were presented to the class. More engineers gave presentations in the class than many students noted when surveyed. Since these women presenters did not fit the stereotypic image of an engineer, perhaps the women students didn't really think of them as being engineers. A similar phenomenon was noted when reporting numbers of women faculty and women engineering students.

Summary and Recommendation for Further Study

The women studied in these experiments came to the university with an academic advantage over their male colleagues. They possessed very positive attitudes, were well-adjusted to their nontraditional career choice, had a high level of confidence and were committed to being persisters in engineering. However, many women changed majors, and reported not liking engineering. Those who stayed evidenced no academic superiority on the average when compared to their male counterparts.

In view of these findings, emphasis needs to be placed on the important transition period between high school and college. What happens to this academically superior group of women when they matriculate at college that causes them to lose their academic advantage? Co-operative programs between high schools and colleges and an increase in dialogue between the science/math high school teachers and college instructors may be beneficial.

Reasons for exiting engineering need to be further explored. Women report that they leave engineering because they have a change in career plans and because they do not like engineering. The reasons for this occurring at a higher rate for the females than the males needs to be ascertained.

Finally, the effectiveness of a support class needs to be further examined. This study suggests that retention rates may be improved even after one semester utilizing such a class. A long term follow-up study on retention patterns of students receiving support needs to be completed. Other avenues of support for women such as membership in professional organizations need to be encouraged and their effectiveness determined.

While this study dealt with retention of students in engineering and variables affecting success once enrolled, efforts need to be made to get more female students enrolled. Special recruiting and career exploration efforts need to be made with the secondary schools and community colleges.

Recruiting, retention, and support are important if the goal of having a similar number of male and female students successful in engineering is to be attained.

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APPENDIX

MATH QUESTIONAIRE

PART 1 DESCRIPTIVE DATA

NAME __________ SOC.SEC.# __________ AGE ON 9/1/83 ______ MALE OR FEMALE ______ WHITE OR NONWHITE ______

MATH ACT ______ COMPOSITE ACT ______ HIGH SCHOOL RANK ______ MATH COURSE OR COURSES CURRENTLY ENROLLED IN ______

GRADE RECEIVED ____ MATH PLACEMENT SCORE: AA ____ AB ____ AC ____ TRIG ____ CALC ____ ACCURATE PLACEMENT __________

Indicate whether you took the following courses in secondary school. Mark yes or no. Beginning algebra ______

Intermediate Algebra ____ Geometry ____ Trigonometry ____ Analytic Geometry ____ Calculus ____ Biology ____

Chemistry ____ Physics ____ Computer Science ______

PART 2 READ THE FOLLOWING STATEMENTS. THERE ARE NO RIGHT OR WRONG ANSWERS. MARK EACH STATEMENT AS FOLLOWS:

Strongly Agree - Mark 5   Agree - 4   Undertain/Undecided - 3   Disagree - 2   Strongly Disagree - 1

ATTCONF 1. I am sure I could do advanced work in mathematics.

ATTMOTH 2. My mother thinks I'm the kind of person who could do well in mathematics.

ATTFATH 3. My father has strongly encouraged me to do well in mathematics.

ATTSUCC 4. It would make me happy to be recognized as an excellent student in mathematics.

ATTTEAC 5. My teachers have encouraged me to study more mathematics.

ATTMDOM 6. Females are as good as males in mathematics.

ATTUSE 7. I'll need mathematics for my future work.

ANXIETY 8. Math doesn't scare me at all.

ATTEFFM 9. When a math problem arises that I can't immediately solve, I stick with it until I have the solution.

ATTCONF 10. I can get good grades in mathematics.

ATTMOTH 11. My mother has strongly encouraged me to do well in mathematics.

ATTFATH 12. My father thinks I'll need mathematics for what I want to do after I graduate from high school.

ATTSUCC 13. Being regarded as smart in mathematics would be a great thing.

ATTTEAC 14. Math teachers have made me feel I have the ability to go on in mathematics.

ATTMDOM 15. Studying mathematics is just as appropriate for women as for men.

ATTUSE 16. I study mathematics because I know how useful it is.

ANXIETY 17. I haven't usually worried about being able to solve math problems.

ATTEFFM 18. I am challenged by math problems I can't understand immediately.

ATTCONF 19. I'm no good in math.

ATTMOTH 20. My mother thinks I'll need mathematics for what I want to do after I graduate from high school.

ATTFATH 21. My father thinks I'm the kind of person who could do well in mathematics.

ATTSUCC 22. People would think I was some kind of a grind if I got A's in math.

ATTTEAC 23. My guidance counselor would encourage me to take all the math I can.

ATTMDOM 24. I would have more faith in the answer for a math problem solved by a man than a women.

ATTUSE 25. I see mathematics as a subject I will rarely use in my daily life as an adult.

ANXIETY 26. I almost never have gotten shook up during a major math test.

ATTEFFM 27. I would rather have someone give me the solution to a difficult math problem than to have to work it out for myself

ATTCONF 28. For some reason even though I study, math seems unusually hard for me.

ATTMOTH 29. My mother wouldn't encourage me to plan a career which involves math.

ATTFATH 30. My father wouldn't encourage me to plan a career which involves math.

ATTSUCC 31. It would make people like me less if I were a really good math student.

ATTTEAC 32. I have found it hard to win the respect of math teachers.

ATTMDOM 33. Girls who enjoy studying math are a bit peculiar.

ATTUSE 34. In terms of my adult life it is not important for me to do well in mathematics in college.

ANXIETY 35. I usually have been at ease during small weekly math quizzes.

ATTEFFM 36. I think mathematics is the most enjoyable subject I have taken.

ATTTEAC 37. My teachers would think I wasn't serious if I told them I was interested in a career in science and mathematics.

ANXIETY 38. Mathematics homework usually makes me feel uncomfortable and nervous.

H.S.BACK 39. Overall, I had good math teachers in high school.

ANXIETY 40. I get a sinking feeling when I think of asking questions in math class.

H.S.BACK 41. I usually had homework in math in high school.

ANXIETY 42. My mind goes blank and I am unable to think clearly when working mathematics.

H.S.BACK 43. I avoided taking some advanced math classes in high school because I didn't want to lower my grade point average.

ANXIETY 44. Walking into a college math class the first time would scare me.

ENGINEERING EXIT INFORMATION

NAME ______________________ SOCIAL SECURITY NUMBER ______________ AGE ________ SEX ________

DID YOU:

_____ WITHDRAW

_____ TRANSFER TO ANOTHER COLLEGE AT ISU, IF SO WHICH ONE

_____ TRANSFER TO ANOTHER INSTITUTION OF HIGHER EDUCATION

_____ BECOME ACADEMICALLY DISMISSED/DROPPED

_____ OTHER -- SPECIFY

HOW DO YOU DESCRIBE YOURSELF?

AMERICAN INDIAN OR ALASKAN NATIVE ________ ASIAN, PACIFIC ISLANDER OR FILIPINO ________

BLACK OR AFRO-AMERICAN ________ HISPANIC, CHICANO OR SPANISH SPEAKING AMERICAN ________ WHITE OR CAUCASIAN ______

ARE YOU MARRIED? ________ DID YOU HAVE A JOB WHILE IN ENGINEERING?________ IF SO, HOW MANY HOURS A WEEK? ________

HOW MANY SEMESTERS WERE YOU IN OUR COLLEGE? ________

Stated below are many reasons why students exit the college of engineering. Please indicate the level of importance of these factors from a 1 (Not Important at all) to a 5 (Extremely Important). Circle the appropriate number.

Not Important At All — Extremely Important

ACADEMIC REASONS:

1 2 3 4 5 A. I had a change in career plans.

1 2 3 4 5 B. I wanted something academically less challenging.

1 2 3 4 5 C. Courses I wanted were not available.

1 2 3 4 5 D. I am dissatisfied with my academic performance.

1 2 3 4 5 E. I am disssatisfied with the quality of teaching.

1 2 3 4 5 F. I am dissatisfied with the learning environment.

1 2 3 4 5 G. The course work was not what I wanted.

1 2 3 4 5 H. I had academic difficulty in my math classes.

1 2 3 4 5 I. I disliked having all problem solving classes.

1 2 3 4 5 J. Engineering just requires too much hard work.

1 2 3 4 5 K. Tutoring was not available to me when I needed it.

1 2 3 4 5 L. I was uncomfortable around the instructors in my classes.

1 2 3 4 5 M. I usually had no one to study with.

Not Important At All — Extremely Important

1 2 3 4 5 N. Academic advising was not adequate.

1 2 3 4 5 O. I didn't really expect to do well in engineering.

1 2 3 4 5 P. I did well in engineering, I just didn't like it.

1 2 3 4 5 Q. Others: Specify ______________________________

FINANCIAL REASONS:

1 2 3 4 5 A. I did not have enough money to continue.

1 2 3 4 5 B. I could not obtain financial aid.

1 2 3 4 5 C. I could not earn money while enrolled.

1 2 3 4 5 D. Other: Specify ______________________________

CAMPUS CONCERNS:

1 2 3 4 5 A. My living/housing arrangements were not satisfactory.

1 2 3 4 5 B. I wanted to be able to participate in more cultural and social events.

1 2 3 4 5 C. Campus recreational programs were not satisfactory.

1 2 3 4 5 D. The College experience was not what I expected.

1 2 3 4 5 E. Others: Specify ______________________________

PERSONAL REASONS:

1 2 3 4 5 A. I left due to a change or anticipated change in marital status.

1 2 3 4 5 B. There were few people I could identify with.

1 2 3 4 5 C. I was uncomfortable in predominantly male classes.

1 2 3 4 5 D. There was a lack of support programs for students like myself.

1 2 3 4 5 E. I felt students of my sex were expected to work harder to get good grades.

1 2 3 4 5 F. There was a lack of emotional support and encouragement from my parents.

1 2 3 4 5 G. Instructors often treat students of my sex in ways that are offensive to me.

1 2 3 4 5 H. There was a lack of emotional support and encouragement from friends.

1 2 3 4 5 I. Others: Specify ______________________________

FR E 101 Women's Section (J & K) Tues. 11

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Mtg			Tues.		Thurs.	
Mtg	1	ACE Profile	Sept.	4*		
	2	Academic Regulations- Enrollment Management		11*		
	3	Prof. Women Eng. talk about their jobs		18*		
	4	E week "Opportunities in Engineering"		25*		
	5	Co-op placement information Panel discussion of experiences	Oct.	2*		
	6	Preregistration information		9*		
	7	Student Services- Professional Organizations		16*		
	8	Dual career engineering families				25*
		Chem E (Room to be announced) EE-Cpr E 117 MacKay		30		
	9	Panel discussion-what's it really like. Students talk about engineering			Nov.	1*
		Chem E Dept - Room to be announced EE-Cpr E - 117 MacKay		6		
	10	FINALE - (For Women's section)				8*
		Chem E - Dept - Room to be announced EE-Cpr E - 117 MacKay		13		
	11	Chem E Dept. - Room to be announced EE Cpr E - 117 MacKay		20		
		"		27		
		"	Dec.	4		
		"		11		

* 145 Sweeney

FR E 101: ORIENTATION & CAREER PLANNING

ASSIGNMENT SHEET
FALL SEMESTER 1984

SESSION	
#1	Course Introduction, ACE Profile
2	Academic Regulations
3	Student Services
4	Co-op Program, Placement Services
5	Basic Program Enrollment Management, Curriculum planning for 2 year period
6	Preregistration instructions
7	Preregistration
8	Cer.E. and Con.E.
9	Met.E. and Aer.E.
10	Surv. and M.E.
11	Ag.E. and C.E.
12	Ch.E. and Nuc.E.
13	I.E. (E.Op.) and E.Sci.
14	E.E. and Cpr.E.

Starting with session #8, some declared students are released to departments, with undeclared and certain curricula receiving information on all engineering areas. Please note the change of meeting locations listed on the back of this assignment sheet.

GRADING: To earn a satisfactory (S):

1. A student must attend a minimum of 6 of the first 7 sessions and 4 of the last 7 sessions.
2. All undeclared (P ENG) students enrolled in the College of Engineering must declare a curriculum to receive a passing grade. All undeclared students must meet with their academic adviser to declare.
3. There will be no make-ups or exceptions.

Sec. A, Wed. @ 10

Session	Date	Place
1	Aug. 29	117 MacKay
2	Sept. 5	"
3	Sept. 12	"
4	Sept. 19	"
5	Sept. 26	"
6	Oct. 3	"
7	Oct. 10	"
8	Oct. 17	"
9	Oct. 24	"
10	Oct. 31	"
11	Nov. 7	"
12	Nov. 14	"
--	Nov. 21	Thanksgiving recess
13	Nov. 28	117 MacKay
14	Dec. 5	"

Sec. J, Tues. @ 11

Session	Date	Place
1	Sept. 4	117 MacKay
2	Sept. 11	"
3	Sept. 18	"
4	Sept. 25	"
5	Oct. 2	"
6	Oct. 9	"
7	Oct. 16	"
--	Oct. 23	No class
8	Oct. 30	117 MacKay
9	Nov. 6	"
10	Nov. 13	"
11	Nov. 20	"
12	Nov. 27	"
13	Dec. 4	"
14	Dec. 11	"

Sec. B, Thurs. @ 11

Session	Date	Place
1	Aug. 30	117 MacKay
2	Sept. 6	"
3	Sept. 13	"
4	Sept. 20	"
5	Sept. 27	"
6	Oct. 4	"
7	Oct. 11	"
8	Oct. 18	"
9	Oct. 25	"
10	Nov. 1	"
11	Nov. 8	"
12	Nov. 15	"
--	Nov. 22	Thanksgiving recess
13	Nov. 29	117 MacKay
14	Dec. 6	"

Sec. L, Mon. @ 10 - Cpr.E./E.E.

Session	Date	Place
--	Sept. 3	Labor Day
1	Sept. 10	117 MacKay
2	Sept. 17	"
3	Sept. 24	"
4	Oct. 1	"
5	Oct. 8	"
6	Oct. 15	"
7	Oct. 22	"
8	Oct. 29	"
9	Nov. 5	"
10	Nov. 12	"
11	Nov. 19	"
12	Nov. 26	"
13	Dec. 3	"
14	Dec. 10	"

Sec. K, Tues. @ 11 - Ch.E.

Session	Date	Place
1	Sept. 4	117 MacKay
2	Sept. 11	"
3	Sept. 18	"
4	Sept. 25	"
5	Oct. 2	"
6	Oct. 9	"
7	Oct. 16	"
--	Oct. 23	No class
8	Oct. 30	117 MacKay
9	Nov. 6	"
10	Nov. 13	"
11	Nov. 20	"
12	Nov. 27	"
13	Dec. 4	"
14	Dec. 11	"

Sec. C, Fri. @ 10 - Ag.E.

Session	Date	Place
1	Aug. 31	117 MacKay
2	Sept. 7	"
3	Sept. 14	"
4	Sept. 21	"
5	Sept. 28	"
6	Oct. 5	"
7	Oct. 12	"
--	Oct. 19	Homecoming
8	Oct. 26	Room to be announced
9	Nov. 2	"
10	Nov. 9	"
11	Nov. 16	"
--	Nov. 23	Thanksgiving recess
12	Nov. 30	Room to be announced
13	Dec. 7	"
14	Dec. 14	"

Sec. D, Fri. @ 10 - Surv.

Session	Date	Place
1	Aug. 31	117 MacKay
2	Sept. 7	"
3	Sept. 14	"
4	Sept. 21	"
5	Sept. 28	"
6	Oct. 5	"
7	Oct. 12	"
--	Oct. 19	Homecoming
8	Oct. 26	Room to be announced
9	Nov. 2	"
10	Nov. 9	"
11	Nov. 16	"
--	Nov. 23	Thanksgiving recess
12	Nov. 30	Room to be announced
13	Dec. 7	"
14	Dec. 14	"

Sec. E, Fri. @ 10 - C.E.

Session	Date	Place
1	Aug. 31	117 MacKay
2	Sept. 7	"
3	Sept. 14	"
4	Sept. 21	"
5	Sept. 28	"
6	Oct. 5	"
7	Oct. 12	"
--	Oct. 19	Homecoming
8	Oct. 26	Room to be announced
9	Nov. 2	"
10	Nov. 9	"
11	Nov. 16	"
--	Nov. 23	Thanksgiving recess
12	Nov. 30	Room to be announced
13	Dec. 7	"
14	Dec. 14	"

Sec. F, Fri. @ 10 - Met.E.

Session	Date	Place
1	Aug. 31	117 MacKay
2	Sept. 7	"
3	Sept. 14	"
4	Sept. 21	"
5	Sept. 28	"
6	Oct. 5	"
7	Oct. 12	"
--	Oct. 19	Homecoming
8	Oct. 26	Room to be announced
9	Nov. 2	"
10	Nov. 9	"
11	Nov. 16	"
--	Nov. 23	Thanksgiving recess
12	Nov. 30	Room to be announced
13	Dec. 7	"
14	Dec. 14	"

Sec. G, Fri. @ 10 - Nuc.E.

Session	Date	Place
1	Aug. 31	117 MacKay
2	Sept. 7	"
3	Sept. 14	"
4	Sept. 21	"
5	Sept. 28	"
6	Oct. 5	"
7	Oct. 12	"
--	Oct. 19	Homecoming
8	Oct. 26	Room to be announced
9	Nov. 2	"
10	Nov. 9	"
11	Nov. 16	"
--	Nov. 23	Thanksgiving recess
12	Nov. 30	Room to be announced
13	Dec. 7	"
14	Dec. 14	"

Sec. H, Fri. @ 10 - M.E.

Session	Date	Place
1	Aug. 31	117 MacKay
2	Sept. 7	"
3	Sept. 14	"
4	Sept. 21	"
5	Sept. 28	"
6	Oct. 5	"
7	Oct 12	"
--	Oct 19	Homecoming
8	Oct. 26	117 MacKay
9	Nov. 2	"
10	Nov. 9	"
11	Nov. 16	"
--	Nov. 23	Thanksgiving recess
12	Nov. 30	117 MacKay
13	Dec. 7	"
14	Dec. 14	"

NOTE: Individual departments will conduct meeting 8 and any subsequent meetings for sections listed on this side. Some departments may elect not to hold all 14 meetings. Students are, therefore, advised to attend all departmental meetings.

FRESHMAN ENGINEERING ORIENTATION 101

PART 1

NAME ________________ SOC. SEC. # ________________ AGE ________

ADDRESS ______________________________ PHONE# ______________

COURSES CURRENTLY ENROLLED IN: MATH ____________ CHEM ______ PHYSICS __________ ENGINEERING __________

YOU MAY SHARE WITH OTHER FEMALE ENGINEERING STUDENTS ANY INFORMATION LISTED ABOVE ____ YES ____ NO.

INFORMATION LISTED BELOW THIS POINT IS CONFIDENTIAL.

HOW WOULD YOU DESCRIBE YOURSELF? MARK ONE

______ 1. American Indian or Alaskan Native

______ 2. Asian, Pacific Islander or Filipino

______ 3. Black or Afro-American

______ 4. Hispanic, Chicano or Spanish Speaking American

______ 5. White or Caucasian

PART 2

Read the following statements. There are no right or wrong answers. Mark each statement as follows:

Strongly Disagree - 1 Disagree - 2 Uncertain/Undecided - 3 Agree - 4 Strongly Agree - 5

1. NTFA____ Studying engineering is just as appropriate for women as for men.

2. ROLMOD__ I am aware of several women faculty members in engineering at ISU. Indicate how many ________

3. CONFENG_ I am sure I can do advanced work in engineering.

4. OPPENG__ Engineering offers many challenging opportunities for women.

5. SUPPOTH_ My mother has encouraged me to major in engineering.

6. NTFA____ Walking into a college engineering class that was all male would make me feel uncomfortable.

7. ROLMOD__ I am aware of successful women engineers from industry. Indicate how many ________

Strongly Disagree - 1 Disagree - 2 Uncertain/Undecided - 3 Agree - 4 Strongly Agree - 5

8. CONFENG I am confident I will be a practicing engineer some day.

9. OPPENG Women engineers do a variety of interesting and rewarding work.

10. SUPPOTH My father has encouraged me to major in engineering.

11. PEERSUPP I am aware of several successful women engineering students at ISU. Indicate how many ________

12. COMMPER I am very committed to getting a college degree.

13. COMMPER I am very committed to getting a college degree in engineering.

14. NTEA Women who become engineers will make more sacrifices in their personal and social lives than women in other professions.

15. OPPENG Engineering offers many opportunities for women to advance professionally.

16. SUPPOTH My high school teachers thought I wasn't serious when I told them I was interested in a career in engineering.

17. PEERSUP I have friends who are successful engineering students at ISU. Indicate how many ________

18. COMMPER In terms of my adult life, it is very important for me to succeed in engineering.

19. PEERSUP I have women friends that I study with for my math, chemistry, and/or engineering classes. Indicate how many ________

20. COMMPER Being an engineer someday is very important to me.

21. NTEA Women who enjoy engineering are a bit peculiar.

22. SUPPOTH College instructors have encouraged me in my choice of engineering.

23. PEERSUP I plan to or have joined a student engineering group at ISU.

24. PEERSUP I have male friends that I study with for my math, chemistry and/or engineering classes. Indicate how many ________

25. COMMPER I will continue in engineering even if I can maintain only a C average.

26. NTEA I would speak up and let my feelings be known if I were ever discriminated against due to my sex in a class.

27. CONFENG I will be very disappointed if I cannot maintain a B average in engineering.

Items 5, 14, 16, 21, and 27 were recoded for data analysis.