An interpretive case study of perceptions and experiences of undergraduate women in engineering majors at Iowa State University

Mildred Annette Haggray

Iowa State University

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An interpretive case study of perceptions and experiences of undergraduate women in engineering majors at Iowa State University

Haggray, Mildred Annette, Ph.D.

Iowa State University, 1992
An interpretive case study of perceptions and experiences of undergraduate women in engineering majors at Iowa State University

by

Mildred Annette Haggray

A Dissertation Submitted to the Graduate Faculty in Partial Fulfillment of the Requirements for the Degree of DOCTOR OF PHILOSOPHY

Department: Professional Studies in Education
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Ames, Iowa

1992

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TABLE OF CONTENTS

CHAPTER ONE: INTRODUCTION TO THE STUDY 1
  Statement of the Problem 6
  Purpose of the Study 8
    Rationale for Research Objectives 9
  Statement of Assumptions 11
  Limitations of the Study 11
  Significance of the Study 13
  Definition of Terms 13
  Organization of Remainder of the Study 15
  Overview of the Methodology 16
    Research Design 16
    Data Collection 16
    Research Participant Selection 18
    Rationale for Research Design 18

CHAPTER TWO: A REVIEW OF RELATED LITERATURE 21
  Gaining Access 21
  Decline in Enrollments and Persistence Rates 23
  Theoretical Assertions: Classroom Climate 24
  Faculty and Peer Interaction 27
  Personal Fit, Career Aspirations and Academic Preparation 29
  Institutional Culture 30
  Internal Support Systems 32
  Implications of Developmental Theory 33
  Women and Competition 35
  Summary of Literature Review 36
CHAPTER THREE: METHODOLOGY

Selection of Research Participants 38
Sample Selection: Interviews 38
Sample Selection: Focus Groups 40

Methods of Data Collection 41
Data Sources 41
Interviews 41
Interview Questions 42
Focus Groups 44
Surveys 45

Data Analysis 46

Summary of Methodology 48

Validity and Reliability 49
Establishing Trustworthiness 49
Credibility 49
Transferability 50
Dependability and Confirmability 51

Ethical Considerations 51

CHAPTER FOUR: ANALYSIS OF DATA 53

Introduction 53
Goal of Data Analysis 54
Summary of Analysis Procedures 55
Validity and Reliability 57
Characteristics of Individual Interview Respondents 58
Characteristics of Focus Group Participants 59
Biographical Profiles of Individual Interview Respondents 60

Analysis of Data 65
Classroom Climate 65
Classroom Participation 67
Gaps in Learning and Lack of Voice 68
Class Size and Faculty Attitude 72
Female-Male Ratio 74
Differential Treatment of Women 75
Focus Group Responses on Classroom Climate 77
Sources of Encouragement 79
Sources of Discouragement 81
Summary of Data Related to Classroom Climate 82

Interaction with Faculty and Peers 85
Summary of Data Related to Interaction with Faculty and Peers 89
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Support Systems</td>
<td>91</td>
</tr>
<tr>
<td>Summary of Data Related to Internal Support Systems</td>
<td>99</td>
</tr>
<tr>
<td>Personal Fit with Major, Academic Preparation and Career Aspirations</td>
<td>100</td>
</tr>
<tr>
<td>Perceptions of Self in the Field</td>
<td>104</td>
</tr>
<tr>
<td>Preferred Teaching and Learning Styles and Methodologies</td>
<td>106</td>
</tr>
<tr>
<td>Summary of Data Related to Preferred Teaching and Learning Styles and Methodologies</td>
<td>111</td>
</tr>
<tr>
<td>Description of Survey Data</td>
<td>112</td>
</tr>
<tr>
<td>Description of Sample</td>
<td>112</td>
</tr>
<tr>
<td>Survey Questions: Classroom Climate</td>
<td>115</td>
</tr>
<tr>
<td>Competitive Atmosphere</td>
<td>117</td>
</tr>
<tr>
<td>Discriminatory and Sexist Attitudes</td>
<td>117</td>
</tr>
<tr>
<td>Lack of Encouragement</td>
<td>119</td>
</tr>
<tr>
<td>View of Women</td>
<td>119</td>
</tr>
<tr>
<td>Limited Peer Support</td>
<td>119</td>
</tr>
<tr>
<td>Survey Questions: Internal Support</td>
<td>120</td>
</tr>
<tr>
<td>Lack of Career Information</td>
<td>120</td>
</tr>
<tr>
<td>Limited Internship Opportunities</td>
<td>120</td>
</tr>
<tr>
<td>Limited Formal and Informal Interaction with Professors</td>
<td>121</td>
</tr>
<tr>
<td>Inadequate Advising and Counseling</td>
<td>121</td>
</tr>
<tr>
<td>Uncomfortable Experiences Related to Internal Support</td>
<td>122</td>
</tr>
<tr>
<td>Survey Questions: Personal Fit with Major, Academic Preparation and Career Aspirations</td>
<td>123</td>
</tr>
<tr>
<td>Reasons for Choice of Field</td>
<td>123</td>
</tr>
<tr>
<td>Reasons for Attending ISU</td>
<td>123</td>
</tr>
<tr>
<td>Persistence by Semesters</td>
<td>124</td>
</tr>
<tr>
<td>Grade Point Averages</td>
<td>124</td>
</tr>
<tr>
<td>Personal Fit</td>
<td>124</td>
</tr>
<tr>
<td>Summary of Survey Data</td>
<td>124</td>
</tr>
<tr>
<td>Summary of Findings</td>
<td>126</td>
</tr>
<tr>
<td>Classroom Climate</td>
<td>126</td>
</tr>
<tr>
<td>Interaction with Faculty and Peers</td>
<td>128</td>
</tr>
<tr>
<td>Internal Support Systems</td>
<td>129</td>
</tr>
<tr>
<td>Personal Fit with Major, Academic Preparation and Career Aspirations</td>
<td>130</td>
</tr>
<tr>
<td>Preferred Teaching and Learning Styles and Methodologies</td>
<td>131</td>
</tr>
</tbody>
</table>

CHAPTER FIVE: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Introduction 133
CHAPTER ONE
INTRODUCTION TO THE STUDY

During the past three decades, one of the most significant changes in women's higher education has been the shift away from traditional fields of study, such as nursing and teaching, to such non-traditional fields as science, engineering, law, and medicine (Chamberlain, 1988). From the 1970s to the mid-80s, there was a steady influx of women into non-traditional fields of study such as the natural sciences, engineering, medicine, and law (Chamberlain, 1988).

Non-traditional fields of study are those academic and career fields which have been predominantly occupied by men and are generally characterized as being more prestigious with higher salary levels than traditional academic or career fields (Chamberlain, 1988). Among the non-traditional fields are science, engineering, law, and medicine. Traditional fields of study are academic and career fields which have been predominated by women and have comparatively lower salaries and lower prestige than do many male-dominated fields (Chamberlain, 1988). Traditional academic and career fields include areas such as nursing and teaching.

One of the most dramatic shifts in career choices among women is demonstrated in their increased enrollment in engineering fields. The enrollment of undergraduate women in engineering rose from 2.3% in 1972 to 15.6% in 1986 (Ellis, 1987). A report from the National Science Foundation (1990), entitled, "Women in Science and Engineering," indicates that between 1976 and 1986, the number of women receiving undergraduate degrees in engineering grew from 1,400 to 11,200.

While much of the enrollment data suggest that significant progress has been made in attracting women into such male-dominated disciplines as the sciences and
engineering (Chamberlain, 1988), the data also reflect a growing disparity in the enrollment and rate of retention of women and minorities in these fields when compared to their white male counterparts (Hewitt & Seymour, 1991). Despite governmental, institutional, corporate and philanthropic initiatives and incentives to recruit women into science and engineering fields, women continue to enroll and remain in these fields in disproportionately smaller numbers than do men (Seymour, 1991). Vetter's (1988) research on the demographics of women in science and engineering fields, also shows that since 1984 the number of women receiving baccalaureate degrees in science and engineering has declined. The number of women engineering students peaked at less than 20% of all engineering students in the mid-80s and has continued to spiral downward (Vetter, 1988). According to Vetter (1988), between 1982 and 1986, only 2,000 (31%) undergraduate women in engineering graduated in four years out of approximately 6,500 freshmen women who enrolled. Ten years earlier, 750 (43%) women graduated from engineering majors in four years out of approximately 1,750 who enrolled (Vetter, 1988).

According to the National Science Foundation report, "Women in Science and Engineering" (1990), despite the enrollment gains for women between 1976 and 1986 (from 1,400 to 11,200) the number of degrees earned by women has begun to drop off, especially in engineering, life and social science fields. Black and Hispanic women are significantly underrepresented, as indicated by statistics showing that in 1988, 1,200 blacks enrolled in graduate science and engineering majors, making up about 4% of all enrollments. Hispanic women represented 10,000 enrollments (3.3% of the total) in graduate science and engineering programs in 1988. That number has fallen to 2.5% (National Science Foundation Report, 1990).
Extant research related to the enrollment and retention of women in male-dominated fields, demonstrates the enrollment and matriculation patterns of women throughout science and engineering majors during the past three decades (Chamberlain, 1988). The data also demonstrate how intensive recruitment and retention efforts within colleges and universities, governmental agencies, and the corporate sectors of our society have encouraged new opportunities for women (Evans, 1988). However, despite the increased participation of women in non-traditional academic and career fields, researchers are continuing to grapple with such questions as: "why are women under-enrolled, in proportion to their percentage of the total population, in most science, engineering and mathematics disciplines and in related occupations?" And secondly, "why do women who do enroll in these disciplines, leave them for other majors at disproportionately higher rates than do men?" (Hewitt & Seymour, 1991).

According to Hewitt and Seymour (1991) some studies which have investigated high attrition rates for women in science, mathematics, and engineering majors, suggest that one reason women students are dropping out of male-dominated fields is because of what has been described as a "chilly classroom climate." The "chilly climate" refers to an atmosphere in which negative or stereotypical attitudes and behaviors are allegedly displayed toward women in academic situations (i.e., classes, labs, advising and counseling, etc.) (Hewitt & Seymour, 1991). These attitudes and behaviors tend to be subtle and often manifest themselves in a lack of interest and confidence in the abilities and aspirations of women students, primarily on the part of male faculty and peers. For example, women who were interviewed for a recent study on factors which contribute to high attrition rates among women in science, engineering, and mathematics majors, complained of sexist remarks directed toward them, being made to feel they were
intellectually inferior to male students, receiving undue attention from male faculty and peers, and being made to feel they were encroaching in male only provinces (Hewitt & Seymour, 1991).

The existence of the chilly climate is generally attributed to the attitudes of male [and at times female] faculty toward female students in the educational environment (Hewitt & Seymour, 1991; Sandler, 1987). The result of these attitudes and behaviors is often discouragement from pursuing a particular major and loss of self-esteem and self-confidence on the part of female students (Hewitt & Seymour, 1991; Sandler, 1987; Kuh, 1991).

A number of research studies (Hewitt & Seymour, 1991; Whigham, 1985) dismiss the notion that the attrition rate for women is higher than that of men, because of the long held belief that women cannot handle the intellectual rigor of scientific or quantitative disciplines or that women are less prepared academically than men. According to Widnall (1988), women who persist in science, engineering, and mathematics are often higher achievers than men. Women have demonstrated slightly higher high school grade point averages and academic preparation than men when first entering science, engineering and mathematics disciplines (Hewitt & Seymour, 1991). Women also have a slight gain above men in academic preparation and college grade point averages in these fields. A case in point is offered in the Iowa State University Student Profile Data Report (1990), excerpted in Table 1 on Page 5. The report was prepared by the Office of Institutional Research at Iowa State University. The table represents cumulative grade point averages for male and female students for the 1990 academic year. This report indicates that undergraduate women in engineering at Iowa State attained slightly higher cumulative grade point averages than male students in all classifications in 1990.
While the Iowa State University student grade profile comparisons show only a slight academic advantage for undergraduate female students in engineering, the data infer that female students are capable of achieving and maintaining competitive grade point averages across all classifications when compared to male students.

Table 1. Iowa State University Student Profile (Undergraduate Engineering Majors)

<table>
<thead>
<tr>
<th>Classification</th>
<th>Cumulative GPA</th>
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<tbody>
<tr>
<td></td>
<td>Female</td>
</tr>
<tr>
<td>Freshman</td>
<td>2.57</td>
</tr>
<tr>
<td>Sophomore</td>
<td>2.81</td>
</tr>
<tr>
<td>Junior</td>
<td>2.87</td>
</tr>
<tr>
<td>Senior</td>
<td>2.95</td>
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So, if questions about women's ability to handle the rigor of scientific or quantitative fields and questions about their academic preparation are resolved, why then are women (1) not enrolling at previous rates or in proportion to their percentage of the population and, (2) why are they leaving these fields in such disproportionate numbers when compared to men? These are questions current researchers must continue to explore.

A preliminary examination of the literature does not reveal a definitive set of reasons why women do not enroll and persist in male-dominated disciplines as do men.
However, the literature does indicate that undergraduate women's expectations about their experiences in these disciplines are often unmet and that their actual experiences are often more negative than those of their male counterparts. These differing outcomes may be related to differential treatment based on gender (Sandler, 1987), and may contribute to higher attrition rates among women who enroll in science, engineering, and mathematics disciplines (Hewitt & Seymour, 1991).

If we are to enhance our understanding of issues related to the recruitment and retention of women in male-dominated fields, we must examine the experiences of women in such fields and ascertain how they perceive and understand (1) their "personal fit" and interaction within the learning environment, (2) the support for and realization of their personal and professional goals and expectations and their actual experiences in male-dominated disciplines, and (3) relationships with faculty and peers (Hewitt & Seymour, 1991).

Statement Of The Problem

The problem which provides the focus for this research study is that current literature related to undergraduate women in engineering majors, does not examine the quality and effects of women's educational experiences in these fields from their own perspectives. The retention of women in science and engineering disciplines through graduation and the professional advancement of women in these fields are elusive goals for many women.

A review of the literature has not revealed conclusive reasons for the disproportionately high rate of attrition (loss) of undergraduate women in science and engineering disciplines or for enrollment declines (Hewitt & Seymour, 1991; Whigham, 1985). Furthermore, there are no studies which investigate the range of factors which
may contribute to undergraduate student attrition. Rather, existing studies adopt a priori assumptions (hypotheses developed before investigation; Borg & Gall, 1989) about the most likely cause of student attrition and then focus on a single possible reason (Hewitt & Seymour, 1991).

According to Hewitt and Seymour (1991), the only national data on the causes of attrition in science, mathematics and engineering resulted from the National Longitudinal Study and the High School and Beyond Study conducted by the U.S. Department of Education. The data indicate that the two primary reasons students leave these fields, include finding other more attractive majors (43%) and that the work was too difficult (31%). A major shortcoming in these studies is that they do not respond to questions about the quality of the learning experiences of students (e.g., quality of instruction, relationships with faculty and peers, academic support, etc.). For example, the studies do not ascertain what aspects of the students' experiences were so unfavorable that they viewed other fields as having greater appeal (Hewitt & Seymour, 1991).

While the literature abounds with enrollment data, demographic data, and information on programs for the recruitment and retention of women into non-traditional fields, (Hewitt & Seymour, 1991), there has been insufficient examination of the quality of the educational experience for women in these fields, from their own perspectives. A closer look at women's expectations, perceptions and experiences in their academic programs, through a qualitative approach, may provide more insights into this area from which grounded theory may emerge. Grounded theory (theory that develops from the data) allows for more accurate reflection of the data by uncovering the actual experiences of the research participants (Borg & Gall, 1989). Perhaps additional explanatory theories will help us to better understand why women are not
enrolling and persisting at rates previously achieved or comparable to their representation in the general population.

Hewitt and Seymour (1991) suggest that to offer theories of attrition which are grounded in students' actual experiences, researchers must explore the problems women face in male-dominated majors from their personal accounts of those experiences. Since the problems women face seem to be more intensified in schools of engineering (Hewitt & Seymour, 1991), this research study will describe and examine the perceptions and experiences of undergraduate women majoring in engineering fields at a major research institution. Additional research that seeks to broaden our understanding of what women's experiences are like and how those experiences affect the decisions women make, may contribute fundamental knowledge which could be useful in addressing issues related to recruitment and retention of women in higher education.

Purpose Of The Study

The purpose of this research study is to describe and analyze the perceptions and experiences of selected undergraduate women in engineering majors at Iowa State University. A qualitative research approach will provide the methodological framework for this study. Consistent with the principles of qualitative research, "rich, thick," descriptive data will serve as the basis for analysis and interpretation of the results of this study (Lincoln & Guba, 1985).

Since some studies indicate that academic environment, especially in male-dominated disciplines, may affect the enrollment and retention of women in such majors as engineering and science (Hewitt & Seymour, 1991; Sandler, 1987), the researcher will frame the study within this context. Academic environment factors that will be the focus of this study include: classroom climate, interaction with faculty and peers, and
internal support systems. Related factors that will be examined are perceptions of personal fit within the major (compatibility of individual goals, aspirations, needs, etc., with the academic program), academic and career aspirations, and preferred teaching and learning styles of women students.

Based on a review of the literature, the researcher proposes three central questions for the purpose of focusing the study. These are: (1) What key factors within the educational environment influence the enrollment and retention of undergraduate women in engineering majors at Iowa State University? (2) In what ways do these factors influence the choices women students make in pursuing their educational goals?, and (3) How do women view their educational experiences in engineering in light of the expectations they had upon entering their chosen fields of study?

The general research objective for this study is to describe and analyze the perceptions, expectations, and experiences of undergraduate women in engineering regarding:

A. Classroom Climate
B. Interaction with Faculty and Peers
C. Internal Support Systems
D. Personal Fit with the Major, Academic Preparation and Career Aspirations
E. Preferred Teaching/Learning Styles and Methodologies

Rationale For Research Objectives

The general research objectives stated above emerge from the literature as educational environment factors that may affect the enrollment and retention of women
in male-dominated disciplines (Pantages & Creedon, 1978; Ott, 1978; Foster, 1976). It is reported by Hewitt & Seymour (1991) that women in engineering majors experience significantly more problems which appear to be related to the educational environment than do men in engineering. Women in engineering are also reported to experience more difficulties than men and women in science and mathematics (Hewitt & Seymour, 1991).

A number of other factors are also identified in the literature which seem to influence enrollment and retention of women in male-dominated disciplines. These include: encouragement from parents, faculty, and school counselors, financial support; high achievement in math and science in high school, and female role models (Whigham, 1985; Evans, 1989). The lack of encouragement, inadequate financial and academic support, and weak academic preparation may contribute to reluctance on the part of some women to enroll and remain in male-dominated disciplines (Whigham, 1985).

Some recent research studies indicate that women are not enrolling in science and engineering programs at previous rates and are dropping out in larger numbers than their male counterparts (Hewitt & Seymour, 1991; Vetter, 1988). The number of women enrolling in engineering majors peaked at 20% in the mid-80s and has continued to decline. In addition, Vetter (1988) states that the retention to graduation rate for freshman year women in engineering dropped from 43% in 1976 to 31% in 1986.

In a recent study of enrollment, persistence and performance of Iowa State University new freshmen and transfer students who entered the College of Engineering in 1985, it was found that 980 enrolled that year. (Study of the Fall 1985 Entering Class of Undergraduates, ISU Office of the Registrar, 1990). Of the 980 enrolled, 855 were males and 125 were females. Six years later, 528 males (62%) and 69 females (55%)
The researchers last enrolled in the College of Engineering in 1991. Of those last enrolled for six years in 1991, 59 of the 69 females (86%) graduated and 363 of the 528 males (69%) graduated. Of the total who were enrolled in another college after six years, 56 were females and 327 were males. Of the 56 females, 40 (71%) graduated. Of the 327 males, 207 (63%) graduated. (Study of the Fall 1985 Entering Class of Undergraduates at Iowa State University, Prepared by the Office of the Registrar, 1990)

Because of the disparate data on enrollment and retention patterns of female and male students, attention needs to be given to the widest range of possible explanations for the trends that were previously discussed. However, for the purpose of this study, the researcher will focus on selected aspects of the educational environment identified above which may affect the enrollment and retention of undergraduate women in engineering majors.

Statement Of Assumptions

The researcher assumes that the research participants in the study have responded honestly and completely to the interview and focus group questions. It is further assumed that the research participants understood and interpreted the questions as intended by the researcher.

Limitations Of The Study

This research study will describe and analyze the perceptions and experiences of selected undergraduate women in engineering majors at Iowa State University, through the use of a case study approach. Since the perceptions and experiences of the women will be different and the sample size is limited to nine key research participants, the
findings of this study may not be generalizable to all women in engineering majors at
Iowa State University or at other institutions.

A further limitation of the study relates to the selection of the sample. Since the
respondents who participated in the study were volunteers, the study is likely to reflect a
biased sample. Twenty-five female students received letters requesting their
participation in the study. Twelve responses were received from students indicating an
interest in participating in the study, however, only ten students confirmed after being
contacted. (One student eventually dropped out of the study because of time conflicts).
The study does not examine the differences between those students who agreed to
participate in the study and those who did not. It does appear that those students who
completed the study are highly motivated, high achieving, and self-reliant. The
respondents may differ from those who did not participate on these and other
characteristics, making the findings less transferable in another setting.

While the study focuses on environmental factors that may affect women in
engineering majors, the issues discussed and the findings arrived at may not necessarily
be solely or partially related to gender differences. For example, some of the data from
interview respondents indicate that male students may have similar perceptions and
experiences to female students as it relates to inadequate preparation for engineering
because of a lack of practical knowledge of engineering or scientific concepts.

Finally, the cautious responses given by some of the interview and focus group
participants on questions of differential treatment, harassment and discrimination by
faculty and peers, may not reveal the true extent of their perceptions and experiences.
Some respondents may have given desirable answers to sensitive questions to avoid
perceived future recrimination. For example, one respondent requested that specific
comments she had given about harassment by a professor be deleted from the study.
Significance Of The Study

The findings of this research study may provide faculty and administrators of college science and engineering programs with a broader understanding of the comparatively different perceptions and experiences of women students who are enrolled in engineering majors. The data may provide a basis from which new theories may be generated, yielding a deeper understanding of the experiences of women in non-traditional disciplines. Further, the study may enhance our understanding of the complex, interrelated environmental factors which appear to impact the enrollment and retention of women in more disparaging ways than they affect male students.

The study may also benefit the key research participants by creating greater self-awareness of their perceptions about their academic experiences. Participation in the research study may also help the participants to clarify for themselves their career goals and choices through heightened awareness and understanding of the factors which influence their decision-making.

Definition Of Terms

The following terms and accompanying definitions are provided to clarify distinctive concepts that are used in the study and reporting of the results.

Attrition A decline in the number of individuals enrolling in a major and completing a degree program. Typically refers to students who enroll as freshmen and graduate in four years ("The State of Academic Science and Engineering" (1990), National Science Foundation).
Internal Support Systems. The nature and extent of formal and informal academic and personal interventions and activities from which students derive encouragement, skill enhancement, etc.; for example, through interpersonal relationships with faculty, peers, and mentors, remedial assistance, internships, etc. (As defined by the researcher for the purpose of this study). Note: Social interaction with faculty and peers beyond the classroom, remedial assistance, etc., have shown positive influences on students' educational aspirations and the completion of a bachelor's degree through doctoral degree (Pascarella & Terenzini, 1991).

Chilly Classroom Climate. An atmosphere in which negative or stereotypical attitudes and behaviors are displayed toward women, typically in classroom situations (Hewitt & Seymour, 1991). (For the purpose of this study, "classroom" refers to engineering and or science classes).

Non-traditional Fields of Study. Academic and career fields which are filled predominantly by men and are usually higher paying and regarded as more prestigious than those fields aspired to by women (Chamberlain, 1988).

Traditional Fields of Study. Academic and career fields which are filled predominantly by women and are usually lower paying and less prestigious than career fields aspired to by men (Chamberlain, 1988).

Personal Fit. The comfortable matching of student to college major and environment; based on the skills, attitudes, and expectations of the student and the demands, culture,
etc. of the college major and environment; goodness of personal fit with the major is hypothesized to enhance student persistence in the major (Whigham, 1985).

**Retention** The persistence or continued enrollment of students through completion of their academic programs (Delworth & Hanson, 1980).

**Organization Of The Remainder Of The Study**

The remainder of the research study is organized as follows: Chapter Two includes a review of related literature. The review encompasses a discussion of the shifting demographics of women from traditional to non-traditional disciplines, enrollment and retention patterns of women in engineering fields, related developmental theories about women's intellectual development, and theoretical assertions related to enrollment and retention declines among women in engineering majors.

Chapter Three includes a discussion of qualitative research methods and procedures to be used in this study, along with a rationale statement. Chapter Three also includes a description of the case study design, research participant selection process, and data collection and analysis methods used. General research questions, focus group and interview questions are also included.

Chapter Four provides the results of the data collection and analysis. Results of the study are reported according to relevant themes which emerge from the data.

Finally, in Chapter Five, the researcher provides a summary of the study, theoretical assertions put forth by the researcher and recommendations for future research studies.
Overview Of The Methodology

Research Design

This section of the research study is designed to explain the methodological procedures utilized to conduct the study. The research methodology is based on a qualitative approach. Specifically, the researcher used an interpretive case study research design to describe and analyze the perceptions and experiences of selected undergraduate women majoring in engineering at Iowa State University.

Merriam (1988) suggests that interpretive case studies are useful in "illustrating, supporting, or challenging theoretical assumptions." (p. 28). They also allow the researcher to develop additional theories when existing theories do not adequately explain a phenomenon (Merriam, 1988). Since the body of research on why women are experiencing disproportionate enrollment and retention declines in engineering [and other non-traditional majors] is still evolving (Hewitt & Seymour, 1991), an interpretive case study approach may elicit additional theories for further study. Through inductive analysis of the data the researcher will determine if theoretical assumptions emerge that might explain why some women students in engineering are not entering and remaining in engineering fields at rates comparable to those of male students or at previous rates.

Data Collection

Data for the study were collected through the use of semi-structured individual interviews and semi-structured focus group sessions with undergraduate women in engineering majors at Iowa State University. Access to the research participants was obtained through the Program for Women in Science and Engineering at Iowa State University. Supplemental descriptive data were collected through the use of a survey
administered to undergraduate women in science and engineering majors at Iowa State University. The survey was conducted by the Program for Women in Science and Engineering at Iowa State University during the Spring of 1992. The survey included questions regarding demographic statistics, relevant academic experience data, and quantitative and qualitative questions about women's perceptions of and experiences in engineering.

The Program for Women in Science and Engineering at Iowa State University was created in 1986 to address the underutilization of women students and faculty in science, engineering, and other technical fields, through specialized recruitment, support programs and retention efforts (Women in Science and Engineering Programs, Brochure). The goals of the Program for Women in Science and Engineering include the following: (1) to encourage female students to enter science and engineering fields, (2) to inform parents and educators about ways they can support female students to pursue technical fields, and (3) to provide support and guidance to women studying in technical fields (Women in Science and Engineering Programs, Brochure).

The Program for Women in Science and Engineering sponsors annual career conferences for students, parents and educators; girls in grades 6-12 visit campus lab facilities and attend special workshops. Women already in science or engineering professions, as well as undergraduate women students, conduct workshops where they talk about their experiences in their fields. Parents and educators participate in sessions to help learn ways to encourage and support female students to consider technical careers.

Undergraduate women in science and engineering are also provided support through internship opportunities with major corporations, research opportunities with
faculty, academic and career counseling, participation in an on-campus professional association for women students (i.e., Society for Women Engineers), and scholarships.

**Research Participant Selection**

Research participants who participated in individual interviews were randomly selected from a list of undergraduate women majoring in engineering. The list was obtained from the Program for Women in Science and Engineering. Focus group participants were undergraduate engineering majors who volunteered to participate in a program evaluation survey conducted by the Program for Women in Science and Engineering. The researcher was afforded the opportunity to contribute to the development of the focus group questions and to conduct two focus group sessions. Further discussion of the data collection procedures, research participant selection, and methods used to assure trustworthiness of the data is provided in Chapter Three.

**Rationale for the Research Design**

An interpretive case study enabled the researcher to gather descriptive data about the relationship between the enrollment and retention of women in engineering majors and selected environmental factors or variables that may impact women's career choices. This approach allowed the researcher to offer a comprehensive analysis of the findings.

A qualitative approach offers a unique opportunity for the researcher to create understanding of a problem or situation (Merriam, 1988) by uncovering the multiple meanings of phenomena from the perspectives of those who have experienced the events (Wolf & Tymitz, found in Kniker, 1990). Characteristic of a qualitative research approach is its use of the researcher as the "data gathering instrument" (Lincoln & Guba, 1985). Use of a human instrument allows greater responsiveness and adaptability to
address changing conditions which may affect the phenomena being studied (Marshall & Rossman, 1989).

Borg and Gall (1989) assert that qualitative inquiry relies upon an emergent research design. This means that the researcher must begin with a tentative design and adjust it as new knowledge about the problem emerges. With this concept in mind, the researcher acknowledges that additional variables may emerge that were not anticipated prior to the study. The adaptability of the interpretive case study design used for this study, will allow for inclusion of additional research questions and the study of unanticipated variables.

An added value of a case study for this research study, is that the researcher will be able to hear first-hand the thoughts, perceptions and experiences of the research participants. Qualitative research methods produce "a descriptive record of written and spoken words and behaviors" (Taylor & Bogdan, 1975. p. 1-11). According to Kniker (1990), qualitative research enables the researcher to: (1) evaluate events, phenomena and behaviors which cannot be measured quantitatively, (2) describe unique situations or events, (3) describe the attitudes and behaviors of people from their own points of view, and (4) reveal systemic human behaviors.

Each of the above descriptors confirms the usefulness and compatibility of a qualitative approach to study the perceptions and experiences of women in such male-dominated majors as engineering. For example, it is the researcher's assumption that women students are better able to explain and evaluate their educational experiences than someone on the outside of the situation. How women's personal goals, career aspirations, academic preparation, and socio-demographic background interact with the structures and culture of their disciplines, can be most accurately told in their own voices. The researcher will endeavor to complement the narrative process by bringing
to the study her understanding of the problem or situation to be studied and by utilizing her research skills to elicit useful information. Finally, the researcher will interpret the results as accurately and clearly as possible, so that the reader will be able to "reconstruct reality from the frame of reference of the research participants" (Borg & Gall, 1989, p. 386).
CHAPTER TWO
A REVIEW OF RELATED LITERATURE

Gaining Access

With women entering non-traditional fields of study in increasing numbers, societal attitudes, norms and expectations about women's roles have been challenged (Chamberlain, 1988). Chamberlain (1988) asserts that the increased participation of women in traditionally male-dominated career fields has challenged some of society's long-standing negative attitudes about women's intellectual abilities and aspirations. For example, a commonly held belief has been that women are intellectually unsuited for the "hard disciplines," such as science, mathematics, and engineering, because of their propensity for working with people rather than things and for using emotion and instinct rather than logic and rational thought in decision-making (Chamberlain, 1988).

Epstein (1991) suggests that societal attitudes and views in relationship to the roles and career aspirations of women have changed; in general, more people now accept as commonplace women who work in non-traditional careers fields, such as scientists, engineers, doctors and lawyers (Cole & Fiorentine, 1991). Epstein (1991) credits the civil rights movement, the women's movement, and the youth movement with changing the rules and definitions related to women's roles.

The large scale movement of women into non-traditional fields of study also created a new perception among women that occupational choices they once considered out of their reach are now accessible. Chamberlain (1988) attributes this perception to equal opportunity legislation enacted during the 1960s and 1970s, which opened new doors for women and minorities by providing access to a wider range of educational and career opportunities.
Educational access for women entering non-traditional fields was further achieved by the provision of financial support from governmental agencies and grants from private foundations (Chamberlain, 1988). In the early 1970s, educational opportunities for women and minorities majoring in science and engineering fields were enhanced by affirmative action legislation and governmental and corporate funding initiatives which were used to attract underrepresented groups into those fields (Chamberlain, 1988).

By the mid-80s, women earned two-fifths (123,000) of all science and engineering degrees, with 45% receiving degrees in science and 15% receiving degrees in engineering (National Science Foundation Report, 1990). According to Welch (1990), the percentage of women engineers in the United States now ranges from 5% to 7% of the estimated 1.6 to 1.7 million engineers.

In 1989, there were 4,315 engineering students at Iowa State University, of which 545 (11%) were women. This percentage increased from 0.5% (18) of women who were studying engineering in 1970 (Works for Women in Engineering, a brochure for the Program for Women in Science and Engineering). This increase has been partly attributed to the recruitment and retention efforts of the Program for Women in Science and Engineering.

Concern over our nation's growing decline in the population of traditional college-age students and a progressively competitive world economy, has turned attention to women and minorities as perhaps the only "untapped" pool of talent left to be recruited to fill the projected future shortfall of scientists and engineers (Hewitt & Seymour, 1991). According to the Office of Technology Assessment report (1989), "Higher Education for Science and Engineering: A Background Paper,"
The number of college-age youths in America is dropping, and will hit its lowest point in 1996...this foreshadows a substantial dip in college enrollments, with science and engineering students suffering a disproportionate drop. This decline might be compensated in part by aggressive college recruiting of women, members of racial and ethnic minorities, and the physically handicapped. (1989, p.14)

National concern for utilizing our nation's human resource potential to promote technological advancement, resulted in the development of the Science and Technology Equal Opportunities Act (Public Law 96-516 of 1980), which mandates that the National Science Foundation compile and report research data on the participation of women and other minorities in science and engineering (National Science Foundation Report, 1990). These data are to serve as the basis for policy development to enhance the recruitment and retention of women and minorities in science and engineering fields.

Decline in Enrollments and Persistence Rates

After more than a decade of intensive recruitment efforts and national initiatives to support the enrollment and retention of women in science and engineering programs, it is perplexing that the number of women receiving degrees in science and engineering fields suddenly peaked (at 20%) and began to noticeably decline in the mid-80s (Hewitt & Seymour, 1991; National Science Foundation Report, 1990). Vetter (1988) who provides further support that this phenomenon exists, indicates that the retention to graduation rate for freshmen year women in engineering has dropped significantly, from 43% who enrolled in 1972 and graduated in 1976 to 31% who enrolled in 1982 and graduated in 1986.

According to a National Science Foundation report, "The State of Academic Science and Engineering (1990), by 1996 a decline of 20% is expected in natural science bachelor degree recipients and a 10% decline is expected in the number of
engineering degree recipients. The National Science Foundation's "Task Force" Report of 1989, indicates that in 1987 white women, who constitute 43% of the total U.S. population, earned 22% of all bachelors and 13% of all doctorates in science and engineering. African-American men and women, who constitute 12% of the U.S population, together possess 4% of all bachelors degrees in science, engineering and mathematics and 1% of all Ph. D's earned. Under representation of women and minorities has been traced from the freshman year through graduate school and in employment after graduation (Hewitt & Seymour, 1991).

Demographic projections indicate a disproportionate loss of academically able students from science, engineering, and mathematics majors. This phenomenon is heightening concern among educators about what is causing the downward shift in enrollment and retention of women in particular, (and low enrollment and retention of minorities) after such steady climbs from the 1970s to the mid-80s (Hewitt & Seymour, 1991). The growing attrition rates for women may exacerbate their existing under representation in most science, math and engineering majors.

Theoretical Assertions: Classroom Climate

Determining why the enrollment and retention rates for women have dropped is a subject continuously under study. However, reasons that are being proposed in some studies are inconsistent and inconclusive (Whigham, 1985).

A study of attrition among science, engineering, and mathematics majors entitled, "The State of Academic Science and Engineering" (National Science Foundation, 1990), indicates a 10% decline in all engineering degrees due to a projected decline in the 22 year old population from 4.4% in 1991 to 4% in 1992. Hewitt and Seymour (1991) contend that these demographic data infer that the lower attrition rates
affect men and women alike and that this may be a normal, temporary decline since the 22 year old population is expected to resurge by 1998. Hewitt and Seymour (1991) assert that "there is a real danger in treating the attrition rates of currently enrolled students as normal" (p. 125). Accepting population declines as the explanation for increased attrition among women and minorities shifts attention away from practices and behaviors which discourage students, such as problems related to pedagogy or the climate within academic departments (i.e., defining certain students as unsuited for a particular field of study because they are not among the most intellectually gifted (Hewitt & Seymour, 1991).

Hewitt and Seymour (1991) conducted an extensive ethnographic study of the educational experiences of 149 students (77 women and 72 men) majoring in science, mathematics, and engineering at four southwestern universities. According to Hewitt and Seymour (1991), some studies that have examined high attrition rates for women in science, mathematics and engineering, attribute the growing rates to the "chilly climate," which some women report experiencing in male-dominated disciplines. This phenomenon refers to the alleged negative attitudes and behaviors of male [and at times female] faculty directed toward women students. It is hypothesized that these behaviors (which may be overt acts of discrimination or subtle messages which demean or disparage women) are manifest in classroom discrimination (Hewitt & Seymour, 1991) and differential treatment of women and men (Sandler, 1987).

Women's experiences in non-traditional disciplines indicate that they tend to experience more gender-related problems in science, engineering, and mathematics than do men (Hewitt & Seymour, 1991). Hewitt and Seymour's (1991) ethnographic study examined factors contributing to attrition among undergraduates in these disciplines and
found that in all areas in which students expressed concerns about their majors, women experienced more problems than men. For example, 30% of the women described feeling that the faculty in science, engineering, and mathematics disciplines did not care about them, while 0% of the men expressed those feelings. Twenty percent of women felt that faculty were "unapproachable" or "impersonal" compared to 12% of the men (Hewitt & Seymour, 1991). It was more important for women students than for men that they be able to establish good relationships with faculty and that faculty possess an affective orientation which embued care and concern for them as well as what they learned.

Another aspect of Hewitt and Seymour's (1991) research reveals concerns by women about their classroom experiences. Women who were interviewed reported receiving subtle cues from faculty that women are less intelligent than men and that women in science, mathematics, and engineering majors are "encroaching in male provinces" (p.98). Nearly all women respondents in the Hewitt and Seymour (1991) study described frequent sexist remarks from male peers and feeling that they were unwelcomed. These types of behaviors are among those which contribute to a cultural climate Sandler (1991) and others regard as "chilly" and unwelcoming for women in male-dominated fields. According to Hall and Sandler (Kuh, 1991), women students are often subtly and overtly stereotyped in certain roles, provided fewer mentoring and leadership opportunities than male students, are more often excluded from study groups and are the objects of sexist humor and sexually harassing behaviors. For example, Hewitt and Seymour (1991) describe the experiences of women students who, over time, decided to dress more inconspicuously or wear unisex clothes and no make-up in order to reduce unwanted attention or hostile behaviors from faculty and peers.
Hewitt and Seymour's (1991) study also revealed another significant factor which in part explained why women chose to switch out of science, mathematics, and engineering majors more often than men. More than 77.9% of women cited as their reason for changing majors the discouragement and loss of self-esteem they experienced from low grades in their first two years. All women who switched majors also mentioned the unapproachability of faculty. Kuh et al. (1991) report that although women students come to college with higher grades than men, they have lower expectations for their college performance than do men. In addition, first year women students exhibit lower self-esteem and lower self-confidence than men in academic ability, math, and public speaking. Kuh et al. (1991) attribute this devaluation in part to the "chilly campus climate" women students face.

Faculty and Peer Interaction

The scarcity of female role models and supportive mentoring relationships like those often afforded male students, inhibits the personal and professional socialization of women. When other problems, such as loss of self-esteem due to declining grades and the lack of internal supports, such as female role models and mentors, exist concurrently with sexist behaviors, other fields become more attractive (Hewitt & Seymour, 1991).

A research study conducted by the National Advisory Group of Sigma XI (1980), examined the human and physical environments within science, mathematics, and engineering majors, the quality of teaching, attitudes and perceptions of students and faculty, and the special needs of underrepresented groups. The findings of the study indicate concerns about large classes, inadequate emotional support, and "weed out" courses which allow into certain majors only the most capable students. Hewitt and
Seymour (1991) point out that some attrition might be due to latent efforts to discourage the "weaker" students, thus reinforcing the notion that those who leave were unfit or unsuited for science or engineering anyway and further restricting all but the exceptional students.

According to Hewitt and Seymour (1991) a larger proportion of women students express concerns about relationships with faculty as it relates to teaching in science, mathematics, and engineering fields. (see Table 2)

Table 2. Concerns about relationships with faculty

<table>
<thead>
<tr>
<th>Concern</th>
<th>Women</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large classes negatively affecting their grades</td>
<td>0%</td>
<td>25%</td>
</tr>
<tr>
<td>The field is too competitive and fast paced</td>
<td>10%</td>
<td>13%</td>
</tr>
<tr>
<td>Professors do not allow time for questions</td>
<td>10%</td>
<td>0%</td>
</tr>
<tr>
<td>Faculty do not know how to teach</td>
<td>0%</td>
<td>13%</td>
</tr>
<tr>
<td>Professors do not have time for students</td>
<td>20%</td>
<td>12%</td>
</tr>
<tr>
<td>Professors do not care about students</td>
<td>30%</td>
<td>0%</td>
</tr>
</tbody>
</table>


Hewitt and Seymour (1991) found that students who switched from an engineering major were influenced by lack of or loss of interest in the field, poor teaching and unapproachability of faculty, low morale due to a competitive culture, inadequate advising during academic difficulty, and unexpected length of time required
to complete their degree. The problems experienced by engineering majors were reported to be more acute than those of students majoring in science or mathematics, with women students experiencing a wider range of concerns. Women who remained in science, mathematics, or engineering to graduation, credited their persistence to being more devoted to their studies, being more intelligent, and having developed coping skills that helped them overcome obstacles in their majors (Hewitt & Seymour, 1991).

Personal Fit, Career Aspirations and Academic Preparation

Pantages and Creedon (1978) suggest that if the skills, attitudes, and expectations a student possesses do not match those of the college (i.e., personal fit), the student is more likely to drop out. The notion of "personal fit" with the educational environment is just as important as are academic preparation, encouragement, and personal desire to pursue a chosen career path (Whigham, 1985).

According to Sandler (1987), the differential treatment of males and females, beginning at infancy, results in expectations and perceptions that are different for men and women. Specifically, if we expect girls and women to be passive and dependent and not interested in math or science, we may well set up self-fulfilling prophecies (Sandler, 1987). In other words, girls and boys become the women and men we expect them to become.

According to Foster (1976) men and women who persist in engineering are more motivated, more committed to engineering, and have strong high school records. In addition, self-image and a positive view of the academic environment enhance persistence for both groups.

Hewitt and Seymour (1991) found in their ethnographic study of science, mathematics, and engineering majors, that appropriateness of choice of major or
"personal fit" was a major distinction between men and women students. Women students were more likely to have selected their major because of pressures from family members or former teachers rather than professional interest in the field. Fifty-two percent of the women interviewed indicated that they selected their major because of family pressures compared to 30% of men (Hewitt & Seymour, 1991).

The university environment is the primary educational, cultural, recreational, and social milieu for most students (Morrill, 1980). Research by Heubner (1979) indicates that congruence between a student and his or her milieu or environment enhances achievement, improves overall satisfaction and coping behavior. A poor fit between the student and his or her environment creates increased stress. Heubner (1979) maintains that a good "personal fit" with the educational environment which takes into account the individual's needs, attitudes, goals, and expectations has a positive impact on performance, achievement, and personal growth.

Institutional Culture

Institutional culture in higher education has often been viewed in similar ways to organizational culture which has strongly influenced managerial behaviors (Masland, 1989). According to Pettigrew (1979) organizational culture represents an amalgam of the beliefs, rituals, ideology, values, and language of an organization. These factors are also grounded in the culture of colleges and universities. Institutional culture may affect student life and the atmosphere on a campus, as well as the curriculum and administration of the institution (Masland, 1989). Institutional culture provides a sense of stability and continuity to the social structure of a college or university, and thus perpetuates the traditional values and ideals of the institution. In addition, institutional leaders set the standards and work to maintain the unique culture of the institution.
Pascarella and Terenzini (1991) suggest that while there is little evidence that the academic department or nature of one's discipline has impact on a student's cognitive development, the interpersonal climate of the department may have significant influence on the personal and educational development of students. Frequent interpersonal exchanges with faculty, departmental "esprit de corps," and mentoring experiences, enhance and create an environment that involves student's intellectual and interpersonal learning. It is also important that faculty not intimidate or be intimidated by students, but rather engage students in learning.

The following quote magnifies the issue of quality of campus life for women students within the institutional culture:

...women now constitute over half of the undergraduate student population (Pearson, Shalik, Touchton, 1989)...their status on many campuses is still that of a minority: "outside the norm" (Wilkerson, 1989, p. 29)...outsiders or marginals to the male-dominated world of academe (Moore, 1987, p. 30), "second-class citizens" (American Council on Education, 1987, p. 5)...at best, invisible...at worst victims of sexual harassment, violence and discrimination (In Kuh, Schuh, & Whitt, 1991, p. 296).

Kuh et al. (1991) assert that the presence of growing numbers of women on college campuses, mandates that institutions re-examine their structures, practices, policies and responses to the needs of students. Issues related to campus climate must be addressed. Further, before institutions can move toward development of an accepting multi-cultural environment, an institutional culture must be developed which supports and appreciates differences. In discussing campus climate issues related to women, Kuh et al. (1991), stress the need for colleges and universities to examine assumptions they make about who their students are and what they need from the institution. For example, it is primarily male models of intellectual and moral development which are
used as the measure of all human development, thereby overlooking the differing needs of women, often depriving them of leadership opportunities and personal and career development (Kuh et al., 1991).

Institutions of higher education must assess what changes are needed in their practices, policies, and programs to enhance the quality of the educational experience for women. A male-dominated campus life reflects male dominance in hiring and promotion practices, resource allocation, policy development and decision-making, and institutional commitment to women's issues and concerns (Kuh et al., 1991). Simply recruiting additional women without addressing the campus environment in which women must maneuver, will not change attitudes and behaviors (Kuh et al., 1991).

Internal Support Systems

According to the Hewitt and Seymour study (1991), the majority of science, mathematics, and engineering majors who remained in their majors developed and learned supportive techniques on their own. Most students indicated that using a peer study group was most helpful when they faced academic or psychological problems. While the Hewitt and Seymour (1991) study found positive effects of peer support and counseling among students, ironically peer support systems often fail because of the highly competitive culture in science, mathematics, and engineering.

Among the support techniques students in the Hewitt and Seymour (1991) study found helpful were: (1) faculty and teaching assistant support, (2) development of a less critical attitude about self, (3) time management skills, (4) "sucking up" to the professors, (5) carrying a light load, (6) learning test taking skills, and (7) cheating on exams.
Implications of Developmental Theory

In the late 1970s, Belenky et al. (1986), initiated a study of the intellectual, ethical, and psychological development of adolescents and adults in educational settings. What emerged from their research was the observation that women often feel alienated in academic settings experience gaps in their learning, and doubt their intellectual competence (Belenky et al., 1986). Further anecdotal reports from Belenky's (1986) study indicated that women experienced more difficulty than men in asserting themselves as authorities, expressing themselves in public, and gaining respect for their opinions.

Belenky et al. (1986) maintain that despite the increase in the number of women students in higher education, faculties which are predominantly male, resist debate about whether women and men have different educational needs. It is assumed by faculty that males and females have the same learning styles, needs, and preferences for instructional techniques and therefore can be taught the same way.

Hewitt and Seymour (1991), reported different gender-related problems for male and female students as it relates to teaching practices in science, mathematics and engineering classes. Males reported that among the reasons they dislike large, introductory classes is that they create more competition for grades and are usually taught by less qualified faculty. Women on the other hand reported that large classes are too impersonal; you do not get to know the professors or the professors do not care if you learn (Hewitt & Seymour, 1991). Women, more often than men, reported that teaching in science, mathematics, and engineering was not as good as in humanities or social sciences. Women described faculty in these disciplines as "unapproachable," and "intimidating" (Hewitt & Seymour, 1991, p. 96).
Hewitt and Seymour's (1991) research asserts that women students have a more affective orientation to education and reflects responses which indicate that personal qualities of faculty are more highly regarded by women than their teaching practices. Gilligan's (1982) research may shed some light on this finding. In a study of the moral and intellectual development of women, Gilligan (1982) maintains that women develop morally and intellectually in ways that are different from men, not in ways that are inferior to men, as some previous researchers had theorized. Women's development is not deficient, deviant, or inferior because it does not fall within the boundaries of human development based solely on male theoretical models.

Gilligan (1982) asserts that women are taught to define themselves in terms of relationships with others, to defer to the judgment and opinions of others, and to judge themselves in terms of their ability to care for others. Women often regard maintaining relationships with others as more important than their individual growth and independence. Men, on the other hand, are taught individuality and identity-separation and the value of competition and achievement. Values assumed by men are regarded as the norm and the values held by women are often viewed as deviations from the norm (Gilligan, 1982).

Gilligan (1979) asserts that women have been omitted as subjects of formative research from which major psychological theories have evolved. The selection of exclusively male samples for research has led to conclusions about men which have been erroneously generalized to explain or describe the development and behaviors of women. Belenky et al. (1986) support this assertion by suggesting that little attention has been given to modes of learning and knowing specific to the needs of women. For example, Belenky et al. (1986) state that attributes commonly associated with men, such as competence, critical thought, and autonomy, are studied and valued, while attributes
that are associated with women are ignored. A noteworthy example relates to models of intellectual development, where mental processes involving abstract processes and impersonal considerations are labeled as "thinking behaviors" and associated with males, while mental processes involving personal considerations are labeled as "emotions" and are assigned to women. The result of this distinctive labeling and categorizing of male behavior as superior and female behavior as inferior, is that women's behavior is viewed as deviating from the norm and therefore, "wrong" (Gilligan, 1979).

McClellan (1975) supports the notion that when women do not conform to standards of psychological expectation [based on male intellectual development], the conclusion is usually that something is wrong with the women. McClellan asserts that, sex is one of the most important determinants of human behavior and differences exist between males and females. Since the standards for evaluating behavior are based on men's interpretations of research, data which comes from a predominantly male sample, male behavior is regarded as the norm and female behavior as a deviation from the norm (p. 81).

Women and Competition

Homer (1972) suggests that women fear competitive achievement, a phenomenon which develops out of a conflict between attaining success and retaining femininity. Homer (1972) asserts that when young women perceive that success is eminent, they become anxious about the possible negative consequences, i.e., "threat of social rejection or loss of femininity" (p. 125). This anxiety is especially prevalent when the competition is against men.
Gilligan (1982) refers to research conducted by Sassen (1980) which offers a different perspective on the conflicts experienced by young women as success seems likely or possible. Sassen (1980) suggests that young women have a heightened sense of the emotional costs of success through competitive means. Women fear that success for one person comes at the expense of another, a disagreeable choice for some women who have been socialized to identify and define themselves in terms of relationships (Gilligan, 1982).

According to Gilligan (1982) boys develop through childhood a sense of rules of the game and fair procedures for settling conflicts. Therefore, men who perceive they have played by the rules and won, feel good about their success, rather than guilty about it as do some women.

While perhaps not conclusive, research studies related to the intellectual and moral development of women, women's values regarding achievement, competition and personal aspirations, may assist researchers in determining what combination of factors most positively influence the personal and professional growth, development, and success of women who choose to pursue non-traditional career fields.

Summary of Literature Review

The purpose of this research study is to describe and analyze the perceptions and experiences of selected undergraduate women in engineering majors at Iowa State University. A qualitative approach was used to obtain the primary data for the study.

The limited research studies which have been done on factors affecting the retention of women in science and engineering fields are often inconclusive and contradictory (Whigham, 1985). However, regardless of the inconclusive nature of
existing research, any reports of real or perceived differential treatment of individuals, raise important issues to be addressed by institutions, faculty, staff and students.

While the presence of women in many non-traditional fields may no longer be viewed as an anomaly, women's physical presence in some male-dominated fields is still not always met with a warm reception. Women report being treated differently than men in ways that often disparage them from pursuing their fields of study (Sandler, 1987). Some women have been left with the feeling that women who pursue male-dominated fields of study are less feminine than women who pursue traditional career fields and that women are less capable of handling the heavily quantitative fields than men (Whigham, 1985).

Although the differences in the treatment of men and women majoring in engineering and other non-traditional fields may often appear subtle distinctions, closer examination may shed light into some areas related to how women learn, develop, achieve, and perceive their educational experience and what they find satisfying in that experience. Critical to this discussion is how we regard the different developmental needs of women in higher education in terms of their interaction in male-dominated fields, where neither may have been socialized to understand and accept the differences.
CHAPTER THREE
METHODOLOGY

The purpose of this section of the study is to provide a comprehensive discussion of the methodological procedures used by the researcher to conduct the study. Included in this discussion are (1) sample selection procedures, (2) research design, (3) data collection methods, (4) data analysis and reporting procedures, and (5) validity and reliability measures.

Selection of Research Participants

The intent of this research study is to provide a detailed description and analysis of the perceptions and experiences of nine women in engineering majors at Iowa State University. Undergraduate women students in engineering majors were selected as the key research participants for this study because (1) this group appears to experience more educational environment-related difficulties in their major area of study than men and also some women in other majors (Hewitt & Seymour, 1991), and (2) the researcher is interested in examining current perceptions and experiences of women students since it is a subject of wide debate in higher education today (Hewitt & Seymour, 1991).

The researcher used a combination of individual interviews and focus groups as the primary data sources for this study. Marshall and Rossman (1989) maintain that the use of multiple informants or more than one data collection method (i.e., triangulation) enhances the usefulness of the data for other settings or situations. Supplementary information was acquired from a survey administered by the Program for Women in Science and Engineering and analysis of engineering recruitment and program materials.

The College of Engineering at Iowa State University enrolls approximately 529
undergraduate women in engineering programs (Comparative Enrollment Report, Fall 1991, Iowa State University Office of the Registrar). The selection of undergraduate women engineering students allowed the researcher continuous access to the research participants.

Sample Selection: Interviews

In as much as the nature of qualitative research limits the feasibility of studying large samples, entire processes, or events (Whitt, 1990), purposive or criterion-based sampling procedures were used for this research study. This means that the sample was selected based on previously established criteria, (i.e., being a currently enrolled undergraduate woman in an engineering major). Purposive sampling assumes that the researcher wants to acquire the greatest insight and understanding of the problem or situation being studied (Merriam, 1988).

Typical case selection was used to identify the sample, which means that any prospective research participant who met the criteria could have been sought out and included in the study (Marshall & Rossman, 1989). This approach supports the researcher's contention that the selected sample should be representative of undergraduate women in engineering majors at Iowa State University.

The sample was drawn from a list obtained from the Program for Women in Science and Engineering, which included the names of currently enrolled undergraduate women engineering students. It was the researcher's intent to assemble a cross-section of perceptions and experiences of women for the study. Therefore, the researcher sought to include at least two research participants from each undergraduate classification level (Freshman, Sophomore, Junior, and Senior).
Letters were sent to twenty-five prospective research participants (five in each undergraduate classification) explaining the purpose of the study, introducing the researcher and requesting their participation in the study (see Appendix A). The letter requested return of a detachable form to indicate if they were or were not interested in participating in the study. Positive responses were initially received from twelve women. After follow-up conversations to confirm their participation, ten women agreed to participate in the study. One eventually dropped out because of time conflicts. Therefore, the sample included only nine research participants represented by: two freshmen, three sophomores, two juniors, and two seniors.

Upon receiving a yes response, the researcher contacted each prospective research participant by telephone to further clarify the purpose and goals for the study, to explain the interview process and to schedule the interviews. Individual interviews were completed during April and May of 1992.

**Sample Selection: Focus Groups**

During Spring semester of 1992, undergraduate (and graduate) women in science and engineering majors were sent letters by the Program for Women in Science and Engineering, requesting their participation in a focus group discussion as part of a program evaluation (see Appendix B). Those who agreed to participate in a focus group were randomly assigned to groups of eight to ten women. Focus group participants were informed of the purpose of the study, advised of their rights as research participants, and asked to sign consent forms (Appendix C).

A total of three focus group discussions were held for undergraduate women in engineering majors during March and April of 1992. One of the focus group discussions was facilitated by researchers in the office of the Program for Women in
Science and Engineering. The researcher facilitated two of the three undergraduate engineering focus group discussions for which data are included in this study. The researcher chose to include in the analysis of data only the data collected from discussions that she facilitated to assure greater consistency in the structured focus group questions, as well as follow up questions asked of the participants.

Methods Of Data Collection

Data Sources

Merriam (1991) prescribes that in qualitative research the collection and analysis of the data should occur simultaneously. Data collection for this research study was initiated in March and continued through May 1992. The primary methods of data collection were individual interviews with key research participants and focus group discussions. The data collected for this study from interview respondents and document analysis belong solely to the researcher. The methods used for data collection are described below.

Interviews

The researcher conducted one individual interview session with each of nine undergraduate women majoring in engineering at Iowa State University. The interviews ranged from two to two and one half hours each. In addition, some participants were followed up with by telephone for clarification on questions and responses. All interviews were audio-taped and transcribed. Each research participant received a copy of the transcription of their individual interview so that she could confirm or refute any statements previously made and negotiate any changes with the researcher before the final writing of the study.
Prior to the interview, each research participant was asked to read and sign a consent form to address issues of confidentiality and to inform her of her rights. She was advised that she could decline to answer any questions with which she was uncomfortable and that she could withdraw from the study at any time. Each research participant was asked to select a pseudonym which would be used to identify all transcripts and fields notes to protect their real names. A copy of the consent form is found in Appendix D.

Interview Questions

Each research participant was asked to respond to the same series of twenty-eight questions developed by the researcher. Additional questions emerged from each interview which provided for more depth and clarification of each research participant's responses. Interview questions were designed to elicit information about the research participant's: (1) family background and educational preparation, (2) career goals, decisions, and influencing factors, (3) expectations and perceptions of their academic program, faculty and peer relationships and interactions, (4) academic and personal support systems, (5) description and assessment of personal and professional experiences within their educational environment, (6) learning and teaching styles and needs, and (7) areas of concern for them within their major area of study. Individual interview questions are listed below and in Appendix E.

The following interview questions were asked of each respondent.

1. Would you share some biographical information about yourself (where did you grow up; parents' education/career background; early schooling, etc.)?

2. How did you come to be where you are today? What/who influenced your choices?
3. Why did you choose to study engineering?

4. What are your short term (3-5 years) and long term career goals (5 years and beyond)?

5. What did you expect from your experiences as a student in engineering when you first arrived at Iowa State University? Have your expectations been met? Please explain.

6. How is/has your academic training in engineering at Iowa State University preparing/prepared you to enter your chosen profession?

7. What types of learning experiences have you had in your academic program which you feel were the most helpful? Least helpful?

8. How would you describe your relationships with your professors? Peers?

9. What have been sources of encouragement for you in your academic program? What have been sources of discouragement for you in your academic program? In what ways have you been encouraged/discouraged? Give examples related to male and female faculty, staff, peers and mentors and types of support.

10. How would you describe a typical class period in your major? What goes on? Who participates and talks? Who does not participate or talk? How do people participate and talk? Why do you think the class is the way it is?

11. How does it feel to be in a typical engineering or science class?

12. How are female and male students respectively, treated by male professors? Female and male students? Is there a difference in the way female students are treated compared to male students? If so, how is it different?

13. What is the most effective teaching and learning strategy for you, i.e. how do you learn best? How have you come to know this?

14. How would you describe the teaching styles of your professors? In what ways are they conducive (or not) to your particular learning style and needs/ the learning styles and needs of other women? Please explain.

15. Do you feel that your professors are (1) aware of your learning needs and style? Do you feel that your professors make an effort to vary their approach or style to meet your needs or the needs of other women students?

16. What opportunities are you aware of that are available for women students for internships, leadership positions in engineering associations, or employment? How did you (does one) learn of these opportunities? How do these opportunities compare to those male students have primarily benefited from?
17. What do you like/dislike the most about your academic program? How is it different from or similar to what you expected?

18. Do you feel that you have been successful in your academic program? In what ways?

19. What factors do you feel have been most instrumental in your achievement and success in your academic program? What have been your support systems?

20. What would be helpful to you at this point in your academic program?

21. What did you think about pursuing engineering as a career before you became a student in engineering? Have your views changed? If so, please explain.

22. How would you compare your experiences in your academic program with those of other women students? Do you think that the experiences you have had in your academic program have been vastly different from those of other women? Please explain.

23. Do you think that the experiences of women in your academic major vary according to their classifications (freshman, sophomore, junior, senior)? If so, how?

24. If you could change your experiences as a student in the engineering program at Iowa State University, how would you change them? What wouldn't you change?

25. What advice or suggestions would you give other women students who are considering pursuing an engineering major?

26. If you had it to do over again, would you complete the same academic program? Why or why not?

27. Do you feel that your academic program is doing enough to encourage the recruitment and retention of women students? What suggestions can you offer?

28. Is there an area that we have not discussed or a question I have not asked which you would like to respond to?

Focus Groups

An additional primary data source for the study was focus group discussions with undergraduate women in engineering majors at Iowa State University. The
researcher facilitated two of three focus group sessions conducted as part of a program evaluation self-study of the Program for Women in Science and Engineering. A third focus group was facilitated by researchers conducting a program evaluation in the office of the Program for Women in Science and Engineering.

Focus group participants were asked to commit to one two hour audio-taped session. The focus groups consisted of six to eight undergraduate women engineering majors. Prior to the discussion, participants were advised of the purpose of the focus group and how the data were to be used. They were also advised of their rights to confidentiality and asked to sign a consent form.

The researcher participated in the development of questions for the focus groups in cooperation with the researchers from the Program for Women in Science and Engineering. The focus group questions were designed to elicit information about (2) influences on women's decisions to enter science or engineering fields, (2) perceived factors to which women attribute the low number of women in science and engineering fields, (3) types of academic support which women find beneficial, and (4) any education environment experiences women view as positive and supportive as well as negative and unsupportive in relationship to the achievement of their academic goals.

The researcher obtained transcriptions of the focus group discussions for inclusion in the data analysis. Focus group questions are attached in Appendix F.

**Surveys**

During the Spring of 1992, the Program for Women in Science and Engineering administered a survey to undergraduate women in science and engineering majors at Iowa State University. The survey was conducted as part of a program evaluation to
determine the effectiveness of the Program in supporting the recruitment and retention of women in these fields of study.

The survey included open and closed-ended questions which were related to factors under investigation in this research study. These questions related to classroom interaction and experiences of women students, influences on career choices and motivation, sources of support, faculty and peer interaction, and academic support needs.

The researcher was provided an opportunity to participate in the development of the survey instrument with the understanding that she would be able to incorporate relevant data from the survey into this study. However, since the nature of this study is qualitative, the researcher elected to use only selected supplemental data from the survey, such as demographic data (i.e., ethnic and educational backgrounds, grade point averages, classifications, etc.) and descriptive and narrative data related to the perceptions and experiences of women in their academic programs. The survey is provided in Appendix G.

Data Analysis

Merriam (1988) refers to data analysis in qualitative research as "compressing and linking data together in a narrative that makes sense to the reader" (p. 130). Taylor and Bogdan (1984) assert that "the goal of data analysis is to come up with reasonable conclusions and generalizations based on a preponderance of the data." (p. 139). While these explanations about the goals of data analysis highlight its complexity, they also underscore the importance of this step in the research study.

For the purpose of this study, the researcher generally followed the five analytic procedures proposed by Marshall and Rossman (1989). These include:
(1) **Organizing the data:** the researcher organized the data topically and chronologically, reviewing and noting questions, comments, and observations. The data were unitized to assist in the development of categories. Unitizing refers to identifying the smallest units of information that can stand alone, in order to assist in category development (Merriam, 1988). Units constitute themes which emerge from the data. For example, a unit which refers to women engineering students who indicate that they find participation in sponsored tutorial programs and informal study groups helpful, might translate into categories such as program support and peer support.

(2) **Generating conceptual categories:** categorizing, which is a form of content analysis, aided the researcher in identifying the salient themes from the data that have meaning for the research participants (Marshall & Rossman, 1989). The researcher photocopied the interview and focus group transcripts, then identified units in the margins of the transcripts. For the purpose of categorizing the data, the researcher reviewed each unit, comparing it with all other units to find common or recurring themes. Lincoln and Guba (1981) describe categorizing as an intuitive process because the researcher must determine whether a unit feels like another, that is, the content of each unit is sufficiently alike to place the units in the same category.

(3) **Testing emergent hypotheses (assumptions):** the researcher searched through the data to sift out categories or themes which challenged the theoretical assumptions of this study, i.e., that select environmental factors (classroom climate, faculty and peer relationships, internal support systems) influence the persistence of women in engineering majors. Marshall and Rossman (1989) suggest that the researcher approach the data with skepticism in order to ensure the credibility and usefulness of the data.
Therefore, the researcher evaluated the emergent categories and themes to determine the plausibility of the assumptions which developed from the data. A review of the data was conducted to test the assumptions against the data.

(4) **Searching for alternative explanations:** the researcher analyzed the data, searching for and attempting to identify the most plausible explanation for the enrollment and retention declines of women in engineering, by eliminating other explanations. The ultimate goal was to determine which assumption (s) was (were) most plausible in explaining the problem under study (Marshall & Rossman, 1989). This process was designed to facilitate the building of grounded theory (Marshall & Rossman, 1989).

(5) **Writing the report:** finally, the researcher reported the data using one of Taylor and Bogdan's report writing strategies (Marshall & Rossman, 1989). This approach calls for summarizing the descriptive data and providing a bridge between the data and general theoretical concepts found in the study. This approach provides the link between theory and practical application of the research findings (Marshall & Rossman, 1989).

**Summary of Methodology**

This research study is presented as an interpretive case study. It includes a description and analysis of the perceptions and experiences of selected undergraduate women in engineering majors at Iowa State University. The study focuses on educational environment factors which may influence the enrollment and retention of women in these majors. Classroom climate, faculty and peer interactions and relationships, and internal support systems are the primary variables under study.
The researcher proposed explanatory theories which might help explain why women in engineering majors are not enrolling and being retained in their majors at previous rates or rates comparable to those of their male counterparts.

Validity And Reliability

Establishing Trustworthiness

All research inquiries must be able to respond to questions such as, "how truthful are the findings of the study? What criteria will be used to evaluate the findings? Are the findings applicable in a different setting?" (Lincoln & Guba, 1981). Lincoln and Guba (1981) pose several constructs related to qualitative inquiry that are useful in addressing questions about the trustworthiness of qualitative research. These constructs relate to the credibility (i.e., the accuracy of portrayal of participants' words), transferability (i.e., whether the study would be applicable in another situation), dependability (i.e., the researcher responds to changes in situation being studied), and confirmability (i.e., the data and findings can be substantiated by an external examiner) of the research findings (Marshall & Rossman, 1989). Strategies the researcher utilized to meet criteria for trustworthiness are discussed below.

Credibility

Credibility for the research study was established through the use of triangulation, peer debriefing, and member checks. Triangulation involves the use of multiple data sources to confirm the findings of the study (Merriam, 1988). The researcher used in-depth semi-structured interviews and focus group sessions with women engineering majors as primary data sources. Data from a survey administered to women in science and engineering majors at Iowa State University by the Program for
Women in Science and Engineering were used for additional support of this study. (Merriam, 1988).

Peer debriefing refers to the use of a colleague or peer to comment on the findings, research processes, etc. The researcher used a peer debriefer to evaluate the interview questions for the research participants, to offer suggestions on the steps used in the study, and to check out the theoretical assumptions being proposed by the researcher (Whitt, 1990). The use of a peer debriefer encouraged the researcher to keep personal biases and perceptions in check.

Member checks involved sharing with the research participants the researcher's understandings and interpretations of their words to assure their accurate representation (Lincoln & Guba). Research participants were given an opportunity to affirm or refute any interpretations of their words and to negotiate final representations with the researcher for the final report. The researcher provided copies of transcripts to the research participants for review and comments.

**Transferability**

Erickson (1986) suggests that "producing generalizable knowledge is an inappropriate goal for interpretive research" (p. 175). In case study research, generalizability involves leaving it up to the reader to decide to what extent the findings of the study apply to another situation (Wilson, 1979). A more appropriate goal in qualitative research is that of transferability (Merriam, 1988). In this study the researcher provided a "thick" description to provide the reader with a sufficient base of information from which to determine if the findings are applicable in their particular situation (Merriam, 1988). The use of multiple data sources (interviews, focus groups, and survey data) also enhanced transferability of the findings to other situations.
Dependability and Confirmability

In order to provide sufficient evidence of the objectivity and appropriateness of the decisions and judgments made throughout this research study, the researcher used a combination of strategies proposed by Marshall and Rossman (1989). These strategies are described as follows: (1) the researcher established an audit trail consisting of raw data, (i.e., interview tapes, field notes, original transcriptions of audio-taped interviews, coded transcriptions of audio-taped interviews used for unitizing and categorizing data), drafts of findings, final report of the research study, notes on methodological decisions and notes from meetings with a peer debriefer. An audit trail allows an external examiner to review data collection and analysis procedures and findings to assure the data stand for themselves (Marshall & Rossman, 1989).

Ethical Considerations

The nature of qualitative research requires the researcher to intrude into the private thoughts and personal experiences of the research participants. Thus, an important consideration becomes, "how does the researcher gather the "thick" descriptive data necessary to accomplish the goals of the research without doing harm to the research participants?" (Merriam, 1988). Questions about the confidentiality of the use of the data and anonymity of the participants must be addressed. In this study, the researcher followed the procedures outlined below to honor the ethical considerations of this research effort.

(1) The research participants were informed about the nature of the study, processes to be utilized and how the data would be disseminated and used. Each research participant
was asked to sign a consent form prior to the interview and focus groups and was advised that she may withdraw from the study at any time.

(2) The researcher assured anonymity by maintaining all audio-taped interviews, field notes, consent forms, and any identifying information in the researcher's home. For individual interviews, research participants used pseudonyms which were assigned to their interview transcripts so as not to reveal their real names. Research participants were identified by a pseudonym in the taped transcripts, fields notes, and final research report.

(3) Approval for the study was obtained from the Human Subjects Review Committee at Iowa State University. (see Appendix H)
CHAPTER FOUR
ANALYSIS OF DATA

Introduction

The purpose of this study is to describe and analyze the perceptions and experiences of selected undergraduate women in engineering majors at Iowa State University. Presented in this chapter are the descriptive data collected from the individual interviews and focus group discussions with the research participants and supplemental data from a related survey. A summary is provided of the goals of data analysis for this study and the analytic procedures used by the researcher.

The data are analyzed according to the theoretical constructs or themes upon which the general research objective for the study is based. In the preliminary phases of the study, the researcher identified from the literature several theoretical constructs or themes related to educational environment. These theoretical constructs appear to affect the enrollment and retention of women in male-dominated fields, such as engineering. These constructs are identified in Chapter One. They include: classroom climate, interaction with faculty and peers, internal support systems, personal fit with major, academic preparation, and career aspirations, and preferred teaching and learning styles and methodologies. In addition, significant themes that emerged naturally from the interviews and focus groups are discussed. Supplemental data from a survey are also described in this chapter.

Through examination of the interview and focus group data, emerging themes were assessed for significance, sorted based on consistency with similar themes, and categorized under the theoretical constructs deemed by the researcher as most fitting.

The chapter begins with a summary of the characteristics of the respondents who participated in individual interviews, followed by brief biographical profiles of each
respondent. A pseudonym is used for each respondent so that her anonymity can be maintained. The biographical profiles are provided to give the reader a sense of the context within which the respondents' have developed their values and aspirations, the influences of family or other role models, and the impact of their life experiences on decisions and choices they have made in pursuing their career interests. Context sensitivity in qualitative research offers the researcher a unique perspective on the social and historical contexts of the phenomenon so that greater understanding of the subject under study is achieved (Patton, 1990).

Focus group participants are characterized as a group by major areas of study. In an effort to assure the anonymity of focus group participants, no biographical data were collected.

**Goal of Data Analysis**

"The goal of data analysis for the researcher is to generate reasonable interpretations and conclusions based upon a preponderance of the data" (Merriam, 1988, p. 130). Depth and detail in the data collection and analysis process are essential to achieving this goal. Merriam (1988) refers to data analysis in qualitative research as "a process of making sense out of one's data... data are consolidated, reduced, and interpreted" (p. 129, 130). The data are conveyed through the words of the respondents, enabling the researcher to gain an "emic" perspective of their real life experiences. (Emic is defined as analysis of behavioral phenomena related to internal elements of a system, Webster, 1983.)

"Thick, rich" descriptions, which provide literal depictions of the respondents' experiences, and exhaustive data accumulation are prerequisite in qualitative research (Lincoln & Guba, 1981, p.119). In interpretive studies, "thick, rich" descriptive data are
essential to providing the researcher with as much information as possible about the phenomenon under study so that he or she can arrive at a meaningful level of conceptualization and analysis and reasonable conclusions (Merriam, 1988).

**Summary of Analysis Procedures**

Merriam (1988) proposes that data collection and analysis in qualitative research should occur simultaneously. "Analysis begins with the first interview" (p. 119) and proceeds as the researcher discovers emerging themes and postulates tentative hypotheses which then cause the researcher to redefine his or her questions and assumptions (Merriam, 1988).

To provide a methodological framework for the study, the researcher followed the five analytic procedures for data analysis proposed by Marshall and Rossman (1989). These procedures are described in detail in Chapter Three. These procedures help assure the reader that methods have been adhered to which depict the data in enough detail to demonstrate that the researcher's conclusions are logical. Merriam (1988) suggests that this validation is necessary in qualitative research, just as it is in quantitative research, to assure the reader that the findings are authentic and reasonable.

**Step 1. Organizing the Data**

Organizing the data involved pulling together and sorting all of the collected interview and focus group data in a way that was understood by the researcher and that made the data easily retrievable. Interview and focus group transcripts were reviewed and noted with questions, thoughts, themes, and initial hypotheses of the researcher. Through a process of unitizing the data, the researcher identified meaningful bits of information (e.g. words, phrases, and sentences) and compared and contrasted each in
order to establish conceptual themes. The unitizing was done in the margins of the transcripts (see Appendix I).

Step 2. Category Development

The researcher chose to use a priori (previously established) categories that were presented as the theoretical constructs or themes upon which the general research objective for the study is based (i.e., classroom climate, interaction with faculty and peers, internal support systems, personal fit with major, academic preparation, and career aspirations, and preferred teaching and learning styles). In qualitative research, the researcher may choose to allow categories to naturally emerge from the data. The emergence of relevant themes in data analysis results from the intuitive process of the researcher identifying recurring themes which he or she feels have meaning (Marshall & Rossman, 1989). For example, the researcher may classify a category or theme based on the frequency with which something is mentioned in the data.

It is also allowable for the researcher to establish or "borrow" category schemes (Goetz & LeCompte, 1984, p. 184). Patton (1980) calls such existing designs category classifications or constructed typologies. Using categories previously established by the researcher, she scanned the data to elicit additional salient themes and to determine their fit within the a priori categories. Emergent themes were then assigned according to the a priori categories under which they best fit.

Step 3. Testing Emergent Hypotheses

The researcher examined the data and extracted themes which challenged those theoretical assumptions made by the researcher (i.e., that selected educational environment factors negatively affect the enrollment and retention of women in
engineering majors). The testing of emergent hypotheses against the data began with the researcher evaluating the plausibility of the developing hypotheses by searching through the data for opposing arguments or patterns. Finally, the researcher determined if the data were useful in answering the questions under study or in generating new theories.

**Step 4. Search for Alternative Hypotheses**

The researcher searched the data seeking alternative explanations and establishing logical interrelationships and conclusions supported by the data.

**Step 5. Writing the Report**

Writing the report is a continuation of the analytic process (Marshall & Rossman, 1989). The results of the study were presented in a narrative form. The perceptions, experiences, and observations of the respondents were presented according to their "world views." Descriptive data were then framed within the analysis and linked to the general theoretical constructs.

Actual quotes from individual interviews and focus group discussions were provided to more accurately reflect the meanings of the respondents' words. Descriptive data from the survey and document analysis were summarized to provide the reader a supplemental perspective on the subject under study.

**Validity and Reliability**

To address the issue of rigor and trustworthiness of the data, the researcher used triangulation, member checks, and a peer debriefer. Triangulation or the use of multiple data sources is used to corroborate and illuminate the research in question and to
enhance its usefulness for other settings (Marshall & Rossman, 1989). Multiple data
sources for this study included interviews and focus groups, with supplementary data
from a related survey.

Member checks with individual interview respondents assured the researcher
that she was accurately interpreting the meanings of words conveyed by the
respondents. Member checks involved the researcher repeating and summarizing
comments during the interviews and allowing the respondents to review their transcripts
and to make changes in the data. Copies of the transcripts were given to each
respondent with a request that she provide written comments and suggested changes.
Written comments were received from four of the respondents. One respondent
provided feedback by telephone. Changes that were suggested did not substantially alter
the data.

A peer debriefer was used to get an outside perspective of what the researcher
felt she was hearing and learning from the individual interview respondents. The peer
debriefer examined the research proposal, interview questions, interview transcripts,
methodology chapter, and analysis chapter and made suggestions to the researcher. The
peer debriefer helped to evaluate the credibility of processes used and conclusions
drawn by the researcher.

Characteristics of Individual Interview Respondents

A total of nine undergraduate women in various engineering majors at Iowa
State University participated in semi-structured individual interviews with the
researcher. Initially, the researcher planned to interview ten women with at least two
representing each undergraduate classification level. During the initial data collection
phase, one respondent discontinued her participation in the study because of time
conflicts. The remaining respondents participated in the study through its completion. The respondents who actually completed the study included eight white females and one Asian American. The nine women who agreed to participate in the study represented the majors and classifications shown in Table 3.

Table 3. Respondents' majors and classifications

<table>
<thead>
<tr>
<th>Major</th>
<th>Freshman</th>
<th>Sophomore</th>
<th>Junior</th>
<th>Senior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical Engineering</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industrial Engineering</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Civil Engineering</td>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Ceramic Engineering</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Characteristics of Focus Group Participants

Participants in the focus groups sponsored by the Program for Women in Science and Engineering, included freshmen, sophomores, juniors and seniors. None of the focus group participants were interviewed individually by the researcher. Two focus groups were facilitated by the researcher. Six respondents participated in one focus group and eight participated in a second one. Their majors included: Electrical Engineering, Civil Engineering, Aerospace Engineering, and Mechanical Engineering. The researcher assisted staff of the Program for Women in Science and Engineering in the development of the focus group format and questions.
Biographical Profiles of Individual Interview Respondents

Respondent "Sarah"

Sarah is a junior majoring in Civil Engineering. She is from Illinois. Her father is a businessman. Sarah's parents encouraged her interest in engineering because of the potential for good job opportunities for women in this field. Because of a strong interest and academic background in math, Sarah was encouraged by counselors at various colleges to pursue engineering.

During her senior year in high school, Sarah and her parents visited a number of colleges, after which she decided to attend Iowa State University (ISU). She admits that after receiving a personal letter from the Dean of the College of Engineering at Iowa State, she was convinced of the university's commitment to recruiting women and knew that this was the right place for her. Sarah initially enrolled in industrial engineering and after taking several classes in physics in which she did not do well, decided that the environmental aspects of civil engineering were more appealing. Sarah plans to pursue a Master's degree in environmental engineering, as well as a law degree, so that she can practice environmental law.

Respondent "Shelley"

Shelley is a sophomore at Iowa State University with a major in Ceramic Engineering. She is from southeast Iowa. Both parents attended ISU. Her father has established his own engineering and construction firm. Shelley's parents have always encouraged and supported her interest in engineering.

Shelley describes her high school as having a very poor science program, but a strong math program. She attended a community college for a year after high school to strengthen her skills. Shelley credits a high school calculus teacher with promoting her
interest in engineering by bringing her class to ISU for special engineering programs for prospective students. She attended three to four Society of Women in Engineering and Engineering Week programs during her junior and senior years in high school. At one of these programs she participated in a ceramic engineering demonstration and decided that this was the area she wanted to pursue. Shelley plans to work for awhile after graduation to be certain that this is the field she wants to remain in before she pursues a Master's degree.

Respondent "Jennifer"

Jennifer was born on Long Island, New York and has lived in Minnesota since the age of 8. Her father is an ex-Catholic priest and her mother is a teacher. Jennifer is a junior majoring in Mechanical Engineering. She graduated from high school a year ahead of her class.

Jennifer does not recall anyone in particular encouraging her to pursue engineering. She traces her interest in engineering to the time when she was thirteen years old and attended a state fair where she took an aptitude test for science careers. She was given a list of engineering careers and began researching possible career options and visiting different colleges and universities. At age 15 she knew that she wanted to enroll in engineering at ISU because of "the school's excellent reputation." She wants to get an MBA and work in a management position in engineering.

Respondent "Christine"

Christine is a freshman majoring in Civil Engineering at ISU. She grew up in Omaha, Nebraska. Her father is a piano tuner and her mother is a substitute teacher in the public schools.
Christine attended an all girls, private, Catholic high school which had a strong college preparatory program. She identifies herself as a strong math and science student. She says that her decision to major in engineering was reached through a process of elimination. She wanted a challenging major that was a good fit and also met her personal goals. Engineering offered a variety of options and the opportunity to pursue a career with practical value.

While Christine does not identify specific individuals who influenced her interest in engineering, she says that she was encouraged by the reactions she received from people when they learned of her interest in engineering. Christine has expressed interest in joining the Peace Corps after graduation. She may also consider corporate work, although she is "concerned about the repressive nature of corporations," she says.

Respondent "Karen"

Karen is originally from Iowa. She is a freshman majoring in Mechanical Engineering. Her mother is working on a Master's degree in education and her father works in construction. She completed her entire high school math curriculum during her freshman year and began taking math classes at a community college. She graduated from high school in December 1991 and entered ISU in the Spring of 1992.

Karen credits her sixth grade math teacher with fostering her interest in math and problem solving and getting her involved in special programs. Karen took the SAT in seventh grade as part of a talented and gifted program through Duke University and was identified as a talented and gifted student. She participated in Iowa State's CY-TAG program for talented and gifted students.

Karen also attended a summer internship at ISU in 1991 sponsored by the Program for Women in Science and Engineering. She had the opportunity to work on a
research project in the Mechanical Engineering Department with a faculty member who
she says has been a great mentor. This experience cemented her interest in engineering.
Karen is transferring to Massachusetts Institute of Technology this year, where she has
received a full scholarship (for women and minorities) in mechanical engineering. She
hopes to work in private industry in Russia for awhile after completing her
undergraduate degree.

Respondent "Elizabeth"

Elizabeth grew up in a suburb of Chicago. She is a freshman majoring in pre-
mechanical engineering. Her father is a CPA and her mother is a legal secretary.
Elizabeth attended an all girls, Catholic high school in Chicago, which had a strong
liberal arts emphasis. She states that nearly 90% of the students in her high school
continue on to a four year college or junior college. She completed a strong math and
science curriculum in high school.

Through her high school chemistry teacher, who is a woman, Elizabeth became
acquainted with a women in science and engineering program at the Illinois Institute of
Technology during her sophomore year. Elizabeth expresses deep regard for her
chemistry teacher because of the consistent encouragement she gave her to pursue a
career in engineering. Elizabeth wants to get a Master's degree and perhaps a Ph.D. in
engineering so that she will be able to compete for management positions.

Respondent "Ann"

Ann is a sophomore majoring in Industrial Engineering at ISU. She is from
Iowa. Her mother is a teacher and her father owns a business. Ann attended a small
high school with a limited math and science curriculum. She had no calculus prior to
entering ISU. Ann recalls wanting to be an astronaut at an early age. Her interest in math, science, and drafting made engineering a logical choice, she says. During high school, she attended summer career conferences at ISU, sponsored by the Program for Women in Science and Engineering. She indicates that these conferences helped to reinforce her interest in engineering. She enrolled in aerospace engineering and later switched to industrial engineering after consulting with staff in the Program for Women in Science and Engineering and faculty in other departments.

Ann's father encouraged her to pursue engineering, but her mother expressed concerns about the "hardness of the field," and the intensity of the competition within a male-dominated major, but she receives encouragement and support from both parents. Ann eventually wants to work in private industry.

Respondent "Kelley"

Kelley grew up in Iowa. She is a junior majoring in Industrial Engineering at ISU. Her mother and father work in engineering professions. While in high school Kelly was active in math competitions and science groups. A high school counselor encouraged her interest in math and science. Although Kelley had no idea what she wanted to major in, her parents encouraged her to pursue an engineering major, rationalizing, she says, that it would be easier to get out of an engineering program later if she didn't like it, than it would be to get admitted into one. Her parents' employment in engineering was also a major factor in her choice of major. Kelley wants to pursue a Master's degree in engineering and work in manufacturing management in private industry.
Respondent "Dana"

Dana is from Iowa and is a senior majoring in Ceramic Engineering at ISU. She attended parochial schools where she received strong academic preparation in math and science. Dana was able to place out of several core courses at ISU, including first semester calculus and English 104.

Dana was encouraged to enroll in engineering by her high school counselor and chemistry teachers. She was encouraged to attend summer internships at ISU while in high school. Her high school chemistry teacher allowed her to monitor the chemistry help room with limited supervision. The faith that her teacher had in her ability to take on this kind of responsibility was a significant confidence builder for Dana.

Dana's parents encouraged her to do her best at whatever she did, but did not push her toward engineering. Her interest in science was nourished by her grandmother who owned a huge mineral collection. Once she thought that she wanted to be a paleontologist or a geologist, but realized she preferred to go into a profession where she could practically apply what she learned in ways that helped people. The potential for jobs and a good salary became an important consideration later.

Dana is a member of the Deans Engineering Ambassadors, a group of ISU students who represent the College of Engineering by visiting with prospective students and talking about careers in engineering. Dana wants to pursue a Master's degree in ceramic engineering after she works for awhile.

Analysis Of Data

Classroom Climate

The differential treatment of men and women in academic environments is reported in various studies as a continuing problem, despite the increasing number of
women who are opting for careers in engineering and other male-dominated fields (Hafner, 1989; Hall & Sandler, 1984; Hewitt and Seymour, 1991; Saigal & Saigal, 1990; Whatley, 1985). Attitudes and behaviors which have reportedly discouraged some women from pursuing careers in male-dominated fields or made completion of such programs difficult for them, have included less time and attention given by faculty and administrators to women students than to male students (Kuh, Schuh, & Whitt, 1991), sexist or discriminatory behaviors directed toward women (Hewitt & Seymour, 1991), attitudes that attribute the success of women to luck or being a minority (Saigal & Saigal, 1990), subtle messages from faculty that they consider women less intelligent than men and therefore expect less from them, and perceptions by men and women that some women take unfair advantage by using their gender to get what they want in the classroom (Hewitt & Seymour, 1991). According to Hewitt & Seymour (1991), the disparaging attitudes and behaviors experienced by some women affect their academic performance and sometimes their will to remain in their majors.

To create a better understanding of the perceptions and experiences of undergraduate women in engineering at Iowa State University (ISU) as it relates to classroom climate, the following individual interview questions were explored with the respondents. (1) How would you describe a typical class period in your major? Who does or does not participate? Why do you think things are this way? (2) How does it feel to be in your classes? (3) What have been sources of encouragement and discouragement for you in your academic program, as it relates to faculty and peer interaction?, and (4) How are male and female students respectively, treated in your academic program?
Classroom Participation

An initial theme that emerges from the data related to classroom climate is that female students participate less than male students in class discussions and are less inclined than male students to raise questions in large classes or in classes where they do not know the other students and the professors. The following analysis will explore some of the reasons for this phenomenon.

All of the respondents describe a typical class period as a large lecture with hundreds of students and little interaction between the professors and students. Significant concerns of most of the respondents include the lack of interaction in large lecture classes and their inability to establish relationships with other students and the professors. All of the respondents said they dislike large lecture classes and do not view them as helpful.

Most of the respondents indicated that they rarely ask questions in class. One respondent commented that students are conditioned to come to class and to frantically take notes verbatim, without ever questioning what they are told. A few professors solicit questions from the class, however most seem to conduct their lecture and dismiss class, according to another respondent. For the most part, when questions are raised in class, male students are typically the ones asking them. Another respondent stated that if she has questions about the lecture, she will ask other students in the class for help or talk with the professor after class. She reports that a common occurrence is for students to ask each other questions about the lecture while the professor is talking so that they can keep up. Rarely will they publicly ask the professor the questions they have.

Many male and female students seem reluctant to raise questions in class. However, the data indicate that female students may be even more reluctant than male
students to raise questions in class. The following quotes from individual interview respondents further illuminate this theme.

Kelly, a junior in Industrial Engineering, responds, "men ask more questions than women [in class]...men come in with more practical knowledge about mechanical things, cars, etc...so the professors view them as more competent...can relate better to them and they get better grades."

Shelley, a sophomore in Ceramic Engineering, supports this view. She says that the students who ask questions are those who have some knowledge about the subject. "They are usually the guys who understand better."

Jennifer, a junior in Mechanical Engineering, states, "males are more vocal...professors always ask men the questions...never ask a girl." If no one speaks up and they [professors] want an answer and don't want to give the answer, they call on a man because they think it might look like they're picking on the girls...oddly its relaxing to know that you won't get called on, so you don't have to always be prepared in class." Jennifer also admits, "I feel vulnerable asking professors questions, because I may get shot down and made to feel stupid. She says, "by the end of the semester I'm not saying anything."

Elizabeth, a freshman in Pre-Mechanical Engineering, says that, "most students are intimidated, the women are more so....they won't raise their hand to ask a question...women sit in the front row and think that since the teacher is male, he won't call on them...male students are more apt to ask questions than females...faculty expect males to ask the questions."

Only two of the nine respondents indicated that they do not feel there is a difference in the way women and men interact in class or how they are responded to by the professors. For example, Sarah, a junior in Civil Engineering, feels that some men in her classes also have a lack of exposure to practical things and are therefore at an equal disadvantage with female students.

**Gaps in Learning and Lack of Voice**

Another theme that emerges from the data is that most of the respondents recognize significant gaps in their learning that affect their self-confidence and
interaction in the classroom. Overwhelmingly, what emerges from the collective responses of most of the interview respondents is a feeling of being uninformed, unprepared, or having gaps in their learning when compared to male students in their classes. The responses of several women also exhibited feelings of powerlessness, a lack of respect for their ideas, and a lack of "voice" in the classroom. There seems to be an uneasy acceptance by some of the respondents of the view that men in male-dominated areas are the authorities and they [women] can only expect to learn from them. As a result, some women are usually silent in the classroom even though they may have something to say.

A recurring comment from several respondents is that male students typically come into engineering with some practical knowledge or experience, therefore they are better prepared than female students. The data indicate that the silence of some women in the classroom is reinforced when professors do not call on women students in class or when they encourage male interaction by directing difficult questions to male students and not to female students. In addition, several respondents expressed feeling discouraged when professors make assumptions about what students in the class know. For example, one respondent described a situation involving a professor who was discussing parts of a car engine in class and upon getting an affirmative response from several male students that they understood, discontinued his explanation. The respondent remarked that she and several other students in the class were left in the dark. "He assumed we all had previous experience or knowledge about car engines," she said.

Hafner (1989), reports that women enter college with higher grades than men, but have lower expectations for their performance in college. Hafner (1989) also reports that women's self-esteem declines during their college years and that first year women
students experience lower self-confidence in their academic ability, math ability and public speaking ability. If Hafner's (1989) findings bear out, some women in engineering majors who experience low expectations by faculty may be losing the academic advantage and confidence with which they entered to college. While the data from this researcher's study do not demonstrate that many professors openly discourage women students in their classes, neither do they indicate that many professors challenge, encourage and support active participation and learning for women in their classes.

The experiences described by the majority of the interview respondents are also generally consistent with research conducted by Belenky et al. (1986), related to the psychological development of adolescent and adult women in educational settings. Belenky, et. al. (1986) discovered that women often expressed feeling that there were gaps in their learning that made it difficult for them to be successful. In the case of the women in engineering respondents, most complained about the disadvantage of not being exposed to mechanical or scientifically oriented concepts, like car engines or turbines, while growing up. They presuppose that many young boys, on the other hand, have grown up with some exposure or experience from working with their fathers or other males on cars or reading car magazines. An interest in or fascination with cars and machines has therefore been encouraged in boys, but not in girls. These gaps in learning seem to cause some women in engineering to feel unprepared and uncomfortable in some science and engineering classes. The gaps in learning that some women interview respondents describe and the low expectations that some professors hold regarding the participation of women in class, may contribute to their silence in the classroom. One respondent's perception is that, "women don't really talk about how they feel in their classes..professors won't understand because they view it [being female] as only words..I'm not perceived as equal so how can I be equal?" In reference to how females
and males are treated, she responded, "teachers assume males and females have the same practical knowledge... then the language they use in class is always "he." I find it offensive. It's assumed that if you're an engineer, you're a guy."

Another finding of the Belenky et al. (1986) study suggests that women have more difficulty than men in expressing themselves as authorities. And, according to Gilligan (1986), women are taught at an early age to defer to the judgment and opinions of others and to value relationships and caring above promotion of their own ideas. The data suggest that raising questions in class was regarded by some interview respondents as a public admission of a lack of knowledge about the subject being discussed. Also, for some respondents asking a question which might be perceived as "dumb," could consequently create doubts on the part of others about their competence. So, they maintain their silence rather than risk creating the perception that they are incompetent. One respondent commented that the students who ask the most questions or talk the most in class are those who end up getting the worst grades. Another respondent reported feeling that most of the women in her classes seem unsure of themselves, while men in the class challenge the professors even though they may be wrong. Some respondents indicate that when male students ask questions, they are perceived as knowledgeable, interested, and aware of what questions to ask. The questions male students ask seem to be viewed by male and female students as beneficial to others in the class.

Because women are taught to value relationships and caring about others above competition and achievement (Gilligan, 1986), asserting oneself or challenging another person's ideas might be perceived by some women as creating negative relationships, an outcome with which they are uncomfortable. The response by one respondent on this topic highlights this point. Christine comments,
"I found myself being assertive for other women who were quiet or acted as if they didn't care...outspoken women are rare...those who are outspoken are classified as being men... as being threatening and intimidating, by men and women. even when arguments are won by other women, they [women students] don't show support publicly...they may privately."

Class Size and Faculty Attitude

All of the respondents expressed concerns about large lecture classes in engineering. Small classes and labs were viewed more favorably. All of the women who were interviewed reported that they dislike large lecture classes because they are impersonal and ineffective. They are more comfortable with smaller classes and labs where the atmosphere is more personal, informal, and where you can get to know everyone. This finding is consistent with Hewitt & Seymour's (1991) research which suggests that women have a more affective orientation toward education, preferring classes where you can get to know the professors and students and they can get to know you. According to the Hewitt & Seymour (1991) study, knowing students by name was an indication for female students that professors cared about them and what they learned. The respondents' need or preference for interpersonal interactions as an indication of support and caring in the educational environment, is a theme further emphasized by their comments, which are excerpted below.

Dana, a senior in Ceramic Engineering, talks positively about the overall classroom interactions she has had in her department. She credits much of the positive interaction in her program with the small number of students, which results in classes of about 20 people. "Everyone knows each other...we're all friends...the professors are receptive to entertaining questions," she says. The difference for Dana is that there is an opportunity to get to know the professors and students on a personal basis. In
addition, the small class size allows for more informal interaction with other students, especially work on small group projects. These factors have enhanced the educational climate for her and thus, her satisfaction with the program overall.

Several women in engineering respondents expressed feeling that professors don't care about students. Karen, a freshman in Mechanical Engineering, states, "a lot of them [professors] are here for the research and teaching is what they have to do. I want a professor who is actually going to teach the students." Several respondents commented that there is not a commitment to teaching on the part of most faculty, because research is their first priority. Faculty who just come to class and lecture and show no interest in interacting with the students are perceived as uncaring and unsupportive by many respondents. Faculty who ask students questions during class or do interactive activities in class are viewed as more caring, even if they spend little time interacting with students outside of class.

Overall, the data indicate that respondents view the "best" teachers as those with whom they have personal relationships. Professors who are characterized as "good teachers" are those who are supportive and caring, friendly and open to being asked questions, those who will help students when they have a problem, and who are receptive to students coming in to visit them during their office hours. This finding is consistent with that of the Hewitt & Seymour (1991) study which found that women evaluate their professors on personal qualities, not their teaching practices.

Peers who are described as supportive and caring by respondents are "those who are open to being called when you have a question, and "those who will study with you or help you with problems."
Female-Male Ratio

When asked how it feels to be a woman in their academic major, most of the interview respondents expressed feeling comfortable in their majors, despite the low ratio of women to men. (In a related question, some respondents expressed the need for more women in the major to provide peer support). In both individual interviews and focus group discussions, no one reported having more than three to four women in a class together at any time. A typical ratio seems to be one female compared to 30 males in most engineering classes, with the exception of Industrial Engineering, which is reported by respondents to have the largest concentration of female students.

According to Karen, "I don't look at whether a student is male or female. I look at intellectual ability and study habits." Ann, a sophomore in Industrial Engineering, states, "I am used to being one of a few women in my classes. A lot of my best friends are male." She adds, "still, I would prefer to have more women, but I'm not intimidated by the men in my classes."

The phenomenon of being comfortable despite being the only woman or one of a few women in their major, is inconsistent with at least one critical mass theory which suggests that a critical mass or certain proportion of a population is needed in order to recruit and retain members of the population in a self-sustaining, self-perpetuating cycle (Lantz, 1982). Lantz (1982) suggests that critical mass is 15 to 20%. In the case of the women in engineering respondents, critical mass seems less a concern than being able to meet the requirements of their academic program. Most of the respondents seem to be trying to adjust to their "minority status" or accept the culture of the predominantly male engineering program as a fact of life. Most of the respondents are adamant about completing their degrees in engineering, recognizing that there may be some problems, but the problems do not overshadow their goals. Perhaps the long term benefits of
having a critical mass of women which might improve the educational environmental, seems too distant a goal for these respondents and not one that they consider achievable during their undergraduate experience.

**Differential Treatment of Women**

In response to the question, "how are male and female students treated in your academic program?," all of the respondents reported that they have not experienced discriminatory behaviors by their professors. It was apparent that the interpretation of this question by most of the respondents was narrowed to mean discrimination, rather than differential treatment. The researcher was attempting to generate a discussion about a range of subtle and overt attitudes and behaviors that describe how males and females are treated, however the responses on this question indicated some confusion about the difference between discrimination and differential treatment based on gender.

Two of the respondents remarked that they have never felt or perceived any differences in the way male and female students are treated by professors. In their perceptions, male and female students are treated equally as well or badly by some professors. One of the respondents who expressed that she had not experienced or perceived differential treatment of males and females in her program, stated her belief that women will always be treated differently because they are in the minority. Hewitt & Seymour’s (1991) research provides a unique perspective that further illuminates this perspective. Hewitt and Seymour (1991) discovered that women in their study were experiencing being in a numerical minority for the first time and that this might have contributed to some misperceptions about sexist treatment. Women and men reported being treated in the same manner by faculty, however, because the college faculty's style of interaction and teaching were more consistent with the teaching approaches men were
socialized with as boys, it was a radical change for women who were socialized through more affective teaching approaches. Therefore, women perceived a difference in treatment (a different teaching style) which they believed to be discrimination, but they could not clearly label the behaviors as discriminatory.

Several respondents reported second hand accounts from roommates and friends of biased treatment from professors or condescending attitudes of professors which made women who asked questions in class feel stupid. Jennifer shared feeling discouraged by faculty who showed bias toward male students in their grading practices. To prove her point she explained that throughout the semester she helped a male friend in one of her classes. Based on his grades up until finals, he thought that he was going to fail the course. Jennifer was averaging a "C" in the class. After the finals, the male student received a B and she received a B- in the class. Her perception is that the professor boosted the male student's grade because her friend was "chummy" with him, while she refused to brown nose.

Attitudes and behaviors that perpetuate stereotypical views about women were described by some respondents, but not labeled by them as sexist. According to the data, even when several women students are in classes together, certain behaviors are exhibited by professors and male students which perpetuate stereotypical attitudes about the expected roles of women. One respondent commented that in one of her classes, the professor will never put two girls together to work on a group project...if a girl is in the group the work is more organized and it gets done and the professor knows it." She goes on to say, "the guys like girls in their work group because they think the girl is a better student...if she survived the weed out classes, she must be competent...it's never the girl that does nothing in the group and the guys know it.
She readily admits that she is always the one who must facilitate the group, assign the tasks and organize things. The male students are the ones who primarily do the brainstorming and analysis of the ideas. The expectation that she should organize and facilitate the work in group projects does not seem to offend her. In two instances, interview respondents commented on the fact that it was great to complete a project with a group of men and to be the only woman in the group, because it was perceived as a greater accomplishment.

Focus Group Responses on Classroom Climate

The focus group questions which explored classroom climate issues included the following. (1) How would you describe your relationships with faculty and peers?, (2) How would you describe the way female and male students respectively are treated in your program?, and (3) What have been sources of encouragement and discouragement for you?

Comments related to classroom climate from focus group participants represented attitudes and behaviors that ranged from sexist humor and subtle put downs, to harassment by professors and peers. One focus group participant commented, "this semester my lab partner looked at me and said, "I'll think and you can type. We're women, we can type...we sat there everyday. It was shocking." Another focus group participant reported being harassed by a professor and not receiving credit for her work. She states, "they'll [professors] really support you or they have the power to change the way things are...on the other hand, I have had some very good mentors in my department." Some other participants also reported no problems with their professors, however, sexist attitudes and behaviors from males peers were concerns expressed by several women.
Peer relationships with male students is clearly a problem for some focus group participants. One participant reported being the only women in a class of 30 and while asking a male lab partner a question about a sample was told, "well, it really doesn't matter if you know. You're just a girl anyway." Some respondents said that they challenge such comments, but others downplay or rationalize sexist remarks and behaviors exhibited by male peers. One respondent remarked almost apologetically, they don't really drastically talk down to you, but they do just so you can notice.

Another participant commented, "I'm aware women are treated differently, but it doesn't bother me. I know that's just something I have to deal with...I'm much better with men than with women anyway."

In response to the question, "how does it feel to be in your classes," a third respondent stated, "it doesn't bother me to be the only female...I know that there's some things I'll just have deal with...I'm much better with men than women...I really don't try to act like I have a lot of emotions."

A fourth participant shared, "I am the only girl in my class...they [males] are not friendly at all, and I don't like that class...so, I'm getting a poor grade."

In an effort to ameliorate some of the gender related conflicts that sometimes arise in the classroom, some women engineering students make deliberate attempts to avoid creating or sending mixed messages to male peers who may interpret their "friendliness" or "talkativeness" as a come on. One participant shared, "I will not sit down and talk to a guy next to me for fear he will think that I'm hitting on him. It doesn't matter if the guy is nice, I wait for him to make the first move." Another participant shared a similar attitude, but added that males in her classes aren't friendly with her anyway. She feels that they resent the fact that she makes better grades than they do. A respondent who is majoring in mechanical engineering commented that male
students will never approach a female student in class to ask for help. The perception of being viewed as outsiders and not being able to do anything about it was apparent among several of the participants.

**Sources of Encouragement**

By asking the question, "what have been sources of encouragement and discouragement for you in your academic major?" the researcher was attempting to find out if there are factors related to classroom climate that encourage and support women or discourage and neglect them. A major theme that emerged is that most of the interview respondents identified their inner strength and self-reliance as the greatest sources of encouragement for them. Other respondents identified sources of encouragement as continuous parental interest and support, having the opportunity to participate in special internships or programs, encouragement by faculty and peers, the feeling that the major is a good fit, being surrounded by positive people, being around successful female role models, and getting good grades in difficult classes. One respondent spoke positively about efforts within the Civil and Construction Engineering department to establish a women's network to encourage women to enter and remain in the program. Most respondents indicated that they are encouraged by learning a lot in their majors, primarily from classes and labs that provide opportunities to apply what they have learned and internships where they can get practical experience.

Sources of encouragement identified by focus group participants included: self-determination, parental support, female faculty role models, friendly, positive attitudes of faculty, trust by faculty in your abilities, meeting other female students in your major, having a network of people to show you the ropes, and tutorial support.
For the most part, encouragement for many of the interview respondents and focus group participants is related to their own interpersonal characteristics, such as their sense of self worth (self-reliance, inner strength, self-determination) and relationships with others (parents, faculty, peers, role models). Hewitt & Seymour (1991) found that by the time a young woman arrives at college, her sense of self-worth is often completely extrinsic. She has been singled out by well-meaning teachers as a promising student and provided lots of attention. In turn, she performs and tries to do her best to please those who have promoted her. In other words, she has become dependent on the approval of other people to validate her achievements and to strengthen her motivation. Evidence of this finding is demonstrated in the comments of one focus group participant who remarked, "my parents and family hold strong expectations that I will become an engineer and take care of the family. I must perform well so as not to disappoint them. I couldn't think of a second choice."

Another finding that is reinforced by the data from this researcher's study is that most of the respondents had nurturing, supportive relationships with grade school and or high school teachers or counselors who they credit with cementing their interest in engineering. While the data do not indicate the gender of all of the teachers and counselors, the presence of female role models in each respondent's life is strong. Thus, it becomes clearer how important it is for young women students to develop perpetual, supportive relationships with female role models and faculty mentors so that their adjustment from high school to college is enhanced. These relationships must augment each other in order to provide effective support and encouragement, according to Hewitt & Seymour (1991). They found, for example, that peer support is ineffective when it is the only source of support for a student who is facing academic or other problems.
Sources of Discouragement

Among sources of discouragement interview respondents shared are: a lack of friends and peer support, lack of supportive faculty, not getting the same good grades they received in high school, professors who are biased towards male students, unnecessary stress of class work, lack of support from the mathematics department, the competition of "weed out" classes, and difficulty understanding and working with foreign teaching assistants. Difficulty understanding foreign teaching assistants and professors who do not respond to students' questions and concerns were cited by the majority of respondents as significant sources of discouragement.

Sources of discouragement for focus group participants included: a lack of friends upon arriving at college, lack of familiarity with ISU, lack of encouragement from faculty, competition of "weed out" classes, intense studying that is required, lack of practical experience and familiarity with concepts in the major area, assumptions by professors about what students know, and programs designed to provide special support for women.

Several focus group respondents commented on the frustration and loneliness they felt as new students who didn't know anyone at ISU. For some respondents it was difficult to find out what they needed to do and where to go for help. Participants in both focus groups cited as a problem the lack of technical support in helping them become familiar with computers and other equipment they would be expected to work with in class. In addition, the majority of respondents indicated that an orientation to "engineering" and what would be required of them in classes would have made their first year easier to get through.

The assumption that professors are biased, unsupportive and don't care about students, that the course load is intentionally demanding and stressful, and the perceived
existence of "weed out" classes, were inferred by some respondents as systematically working together to eliminate all but the best students from engineering. Several respondents commented on the unofficial comments or subtle messages they received that many of them would not make it through introductory courses.

Receiving average and below average grades for the first time was surprising to many respondents. All interview respondents expressed disappointment that they have not been able to maintain the good grades they received in high school and some admit that they are just now learning how to study for the first time. In a survey of 482 freshmen women enrolled in freshman engineering at Iowa State University, Evans (1989) found that 79.6% of those who were identified as persisters in engineering, cited dissatisfaction with their academic performance as a cause of dissatisfaction with the engineering program (although 46% had at least a 3.0 grade point average at the end of the semester).

Concerns about foreign teaching assistants by interview respondents related to the perception of some respondents that while many foreign teaching assistants want to help students understand the subject, translation of languages presents a barrier for both. Some students report having difficulty expressing their questions or problems in a way that the teaching assistant understands what is being asked or explained. As one respondent put it, "often the answer that the teaching assistant gives is in response to a different question." Some respondents report that they give up trying to understand out of frustration and just try to make it through the semester.

Summary of Data Related to Classroom Climate

According to Evans (1989) women who enroll in engineering majors are more vulnerable than men when it comes to successfully negotiating their way through the
competitive academic culture and responding to the pressure of being an isolated minority. Research studies have proven that women are academically capable of understanding the concepts in engineering, so the notion that women are less prepared than men can be dismissed (Hewitt & Seymour, 1991). Although women who persist in engineering, science, and math majors tend to be higher achievers than male students, women seem to encounter more problems in engineering than men. Women students in the Hewitt & Seymour (1991) study experienced problems due to the impersonal nature of large lecture classes and the inability to get to know their professors and peers personally, both of which run counter to the teaching styles and expectations young girls are socialized to expect. Added to the lack of affective orientation in the classroom are attitudes and behaviors exhibited by some professors and peers which disparage and discourage women. Messages are conveyed subtly and overtly, that question women's intellectual abilities or their seriousness about pursuing a career in engineering. Feelings of being unwelcome or that they are trespassing in male provinces are often expressed by women in engineering and other male dominated disciplines (Hewitt & Seymour, 1991).

Saigal and Saigal (1990) found in a study of 350 male and female engineers who work in various organizations, colleges, and universities, that 27% of the men expressed the belief that women engineers have less ability than women and 16% of men feel a woman's success in engineering is due to luck or being a minority, rather than because she has the skills. No women surveyed felt the same. Comments from some interview respondents and focus group participants reflect similar attitudes, especially on the part of male peers. One interview respondent spoke of resentful attitudes of male classmates because she makes better grades than they do. A second respondent also commented that male students "get aggravated with women who get better grades than they do." She
states, "they rationalize that the reason a women does well academically is because she's cute or she flirts with the professor." Another mentioned that her male peers in one of her classes do not associate with her and would never ask her for help in class because she is a woman.

In a study conducted by the Fund for the Improvement of Postsecondary Education, it was concluded that the problems women experience in higher education, (e.g., lowered self-esteem, inhibited learning, lowered academic aspirations, lack of self-confidence, etc.) may be related to the way they are treated in the classroom (Sandler, 1987). Sandler (1987), suggests that in addition to overt discrimination and sexist language in the classroom, more damage is done to women by the disparaging remarks from faculty and students about women's intellectual ability, their commitment to academic pursuits, and discouragement and lack of support from faculty.

Despite the disparaging nature of comments or attitudes from some faculty and male peers, most of the interview respondents and focus group participants seem to place the differential treatment they receive aside for now and concentrate on their academic goals. Few respondents have chosen to confront sexist attitudes and behaviors and tend to view them as short term problems. It is not clear from the data how they are personally dealing with the negative affects of being in the male dominated culture they are a part of. Some respondents seem to feel that there are no different obstacles for men and women. The result of the adaptive behavior some respondents exhibited may enable them to remain focused on their academic goals and secure their engineering degrees. However, the lack of reporting of differential treatment and other disparaging behaviors directed toward female students, may perpetuate a negative, unaccepting climate that is debilitating for some women in engineering.
Interaction with Faculty and Peers

While there is a clear connection between the construct classroom climate and faculty and peer interaction, this construct will be discussed separately in this section in order to delineate the issues more clearly. Some data related to faculty and peer interaction are also reported in the section on classroom climate.

The individual interview questions related to interaction with faculty and peers included: (1) How would you describe your relationships with your professors and peers?, (2) In what ways have you been encouraged or discouraged by faculty and peers?, (3) Do you feel that your professors are aware of your learning needs and style and (4) Do professors make an effort to adjust their teaching approach to meet your needs?

Five of the respondents stated that they have had good relationships with faculty. This finding seems somewhat inconsistent with previous responses to the question, "what learning experiences have been most helpful or least helpful to you?," in which several respondents commented that they do not believe professors care about students. It is clear that the respondents make a distinction between professors in large lecture classes who they do not know and professors with whom they have established personal relationships. The perception that "professors don't care" seems to be related more closely to the impersonal nature of large lecture classes rather than specific behaviors professors have exhibited that clearly indicate they do not care about students. However, some of the data indicate that some respondents feel that even professors in large lecture classes can do some things to demonstrate to students that they care about them (e.g., making eye contact with students during the lecture, not assume all students have the same knowledge, change their tone of voice to demonstrate more patience, etc.)

A consistent theme among five of the respondents is the importance of
developing personal, friendly relationships with their professors so that, "they know who you are." According to Ann, the professors that she likes are the ones she gets along with and who are helpful when she has a problem. Other respondents' comments on this theme are described here. According to Sarah, a junior in Civil Engineering, "faculty in my program are helpful and encouraging, available after class and answer questions during class...lots of women seem pleased." Elizabeth has concluded that faculty will respond to you if you are persistent. She developed the attitude that she will press faculty for answers and help if she needs to. She stated, "most of my professors know me. I ask lots of questions...sometimes they look at me with dread."

Shelley remarked,

women in my major feel good overall about relationships with professors, except some professors are just harder, more impersonal...I don't think it's because you're male or female though.

Jennifer commented that what would be most helpful to her right now is to have a close relationship with at least one faculty member in her department. She expressed strong concerns about her lack of interaction with the professors in the department into which she recently transferred. She states,

I have had difficulty connecting with faculty...I changed to mechanical engineering and feel like an outsider...males in my classes have a connection with the professors that goes beyond the classroom...they talk to the professors easily about the latest engines and cars...as a woman I'm not consumed with engineering and don't spend lots of time reading the journals and looking up turbo jets. No one cares how I'm feeling...they [professors] definitely do not go out of their way to make a connection with women.

One focus group participant expressed the importance of "getting into the right classes where you can develop relationships and the professors treat you well." Some participants shared the feeling that some professors don't care if you make it or not. One
participant shared that a faculty member tried to force her out of the field. Another commented that some male faculty treat women in condescending ways. They "let women get away with stuff." In both the individual interviews and focus groups, students shared the concern that women are not compelled to be prepared in class because they know that the professors are not going to call on them or expect them to participate. As a result, some women may not be developing important interpersonal skills, which may already be deficient (i.e., low self-confidence, reluctance to speak in public, Hafner, 1989).

In Evan's (1989) persistence study of undergraduate women in engineering, 61% of respondents who transferred reported that it was hard to get to know the professors. Nearly twenty one percent of transfers and 7.4% of persisters reported that professors in engineering make jokes about women to make their lectures more interesting. Another 7.6% of transfers and 3.5% of persisters reported that professors made them uncomfortable by commenting on their appearance.

The views of interview respondents about their relationships with peers were varied. Shelley reported that men in her department are caring and supportive. Students go out together, study together and call each other if they have questions.

Shelley stated, "I don't think women in some other engineering majors have good peer support, mostly in programs with large numbers."

Kelley stated that she has learned how to network with her peers and that "things get better the higher you go in your program. The freshman year is the toughest because you don't know anybody," she says.

Christine commented, "I don't see myself as a typical female...I get along better with men than women and find the average girl too petty...I prefer conversations men have because they aren't concerned with clothes and image."
One observation made by several respondents is that the experiences of women regarding relationships with faculty and peers vary by department or major. Departments that were described as supportive of women fall into two categories. Departments with large numbers of female students (e.g., Industrial Engineering) or those with small total numbers of students (e.g., Ceramic Engineering) were perceived by most respondents as more supportive and caring than larger, less diverse departments. In general, departments with a more diverse population or enrollments that are small enough for faculty and students to interact informally and get to know each other, were perceived as the most open, supportive and caring departments by respondents. This finding underscores the importance for some women students of developing relationships with faculty and peers, which link them personally and professionally to their academic programs.

Focus group participants also reported a variety of experiences. Some expressed concern about harassment and stereotypical comments from peers which questioned their abilities. Several respondents shared they do not speak to male classmates or ask to study with them because of the potential for their "forwardness" to be misunderstood by men. Another concern expressed was that men in some classes are unfriendly towards women. As one participant commented, "it's rare if I will study with someone...in the case where the teacher will not give me his notes, I usually go without." Some respondents shared that a number of women have transferred out of their programs because of negative treatment by male students. One participant said, "male students in my major are squirrelly. I would transfer if I could. My tenacity won't allow me to quit."

Although research data related to the affects of faculty-student interaction on student learning are inconsistent, some studies confirm that faculty-student interaction
may positively influence student learning (Pascarella & Terenzini, 1991). Pascarella and Terenzini (1991) further report that faculty influence on student values, behaviors, and attitudes may be enhanced by informal contact outside the classroom. In a related study in which pre-college characteristics and expectations of college were controlled, Endo and Harper (1982) found that frequent, informal contact with faculty had statistically significant positive association with adequate general knowledge and math skills as reported by college seniors. Similarly, frequent informal contact also had significant positive associations with knowledge of basic facts as reported by freshmen. Quality of relationships with faculty was reported as a significant outcome of frequent, informal contact.

**Summary of Data Related to Interaction with Faculty and Peers**

Research data indicate that frequent, informal interaction between faculty and students has positive educational outcomes for students (i.e., student learning is enhanced, quality of relationships between faculty and students is improved) Pascarella and Terenzini's (1991) research provides an important link to informal educational practices that may enhance the academic and developmental success of some women in male-dominated fields, such as engineering. Terenzini et al. (1991) found that a statistically significant positive predictor of perceived gains in academic skills was related to the extent to which a student had developed a friendly, informal, influential relationship with at least one faculty member. Research on the relationship between faculty-student interaction and educational aspiration and attainment, suggests that female faculty role models may significantly influence the educational aspirations of undergraduate women (Esposito, Hackett, O'Halloran, 1987; Ridgeway, 1978; Stoke, 1981). Monteiro (1980) found that women in single sex colleges in which female
faculty are in the majority, have more informal interaction and more support than females in coed institutions. Tidball et al. (1976, 1986) also found a potential link between the number of women faculty at an institution and the percentage of women graduates who receive graduate degrees.

Some research data illustrate the importance of having female role models in male-dominated disciplines to provide the level of interaction and support some women find necessary in order to be successful in their educational pursuits. The data collected in this study, however, seem to minimally support this hypothesis. Only one interview respondent indicated that she felt there would be a positive difference in the classroom if more female faculty were hired in engineering. Most of the respondents could not perceive of ways the environment would change if more women faculty were present. Most of the respondents expressed a higher need to meet other women peers for support than the need for more female faculty. One respondent commented that she would feel sorry for any women who came into a faculty position in engineering because of the way she would likely be treated by male professors and male students.

According to Terenzini and Pascarella (1991), students' peers can be influential in their academic major. They postulate that the largest percentage of peers possessing a given attitude at the time they enter college, the greater the probability that other students will change their own attitude and adopt that of the majority (Pascarella & Terenzini, 1991). Some data suggest that peers can positively influence the educational aspirations of other students. For example, social involvement with peers has shown small, but direct effects on sophomore students' educational aspirations (Pascarella & Terenzini, 1991). While the data do not reflect a difference for men and women, they suggest an important link between peer interaction and realization of educational aspirations for some members of both groups.
Some studies on women's psychological and intellectual development indicate that women tend to have a more affective orientation towards learning and knowing (Hewitt & Seymour, 1991) and that women are taught to define their identity in terms of relationships and connections to others (Belenky, 1986). The realization that differences exist between men and women in their psychological, intellectual, and moral development (Gilligan, 1985) is critical when considering how to design an education that meets the needs of women. The positive educational outcomes for women in male-dominated fields may be enhanced if their academic departments alter the educational structure and past practices to encourage and sustain positive relationships with faculty through informal interaction in and outside of class, mentoring, and research opportunities with faculty.

Internal Support Systems

For the purpose of this study, internal support systems refer to the formal and informal academic and personal interventions and activities introduced into the educational environment, from which students receive skills, support and encouragement to persist in their academic majors. Internal support may include scholarships and internships, mentoring and research opportunities, formal and informal interaction with faculty and peers, peer support and study groups, female role models, and involvement in student organizations.

The interview questions related to internal support systems are: (1) What opportunities are you aware of for women in engineering that relate to internships, scholarships, leadership positions or employment assistance?, (2) How did you learn of these opportunities?, (3) How do these opportunities compare to those provided male students?, (4) What factors have been most instrumental in your academic achievement
in your major?, (5) What have been your support systems, and (6) What would be most helpful to you at this point in your academic program?

Most of the respondents had some awareness that there are internships and scholarships targeted for women in engineering. Most of the respondents were not able to comment on specific internship or scholarship programs. Most were also unable to identify contact people in offices who might have specific information on these types of opportunities. How they learn of these opportunities depends on how involved they are with organizations that assist women in engineering, such as the Society of Women Engineers (SWE) or the Program for Women in Science and Engineering (PWSE). SWE is a campus-based, student organization designed to encourage and support women in engineering careers. The Program for Women in Science and Engineering (PWSE) is a university office which provides information on career opportunities in engineering and sponsors support programs and activities which encourage the recruitment and retention of women in science and engineering (Program for Women in Science and Engineering brochure).

Four of the nine interview respondents said they learned of opportunities for women through SWE or PWSE. These respondents had varying levels of involvement with these programs. Those respondents who were not involved with SWE or the PWSE indicated that they found out about opportunities by chance (e.g., seeing information posted on a bulletin board). One respondent commented,

you find out about scholarships by reading something on the SWE board..you have to go out and find information on opportunities.

Another remarked, "I am aware "that the College of Engineering knows about opportunities, but they don't always let students know in time, so students miss a lot of deadlines."
Christine stated, "I am not aware of many scholarships for women...men have the erroneous perception that all scholarships go to women and minorities...most scholarships are gender neutral and open to men and women, but it's hard to find them."

The data from interview respondents and focus group participants indicated that some women engineering students are not linked into information channels that provide information on scholarships and internships across all engineering majors. There is also a substantial lack of awareness about what offices and programs provide support to women in engineering and what the nature of that support is.

Most of the respondents do not actively participate in SWE or use the support services provided by the PWSE. Those respondents who have taken advantage of activities or programs offered by PWSE and SWE, indicated that they have found both programs helpful in sharing information about internships and scholarships. Some respondents have also used advisers in the office of the PWSE for academic counseling and advice and to assist in making employer contacts and preparing resumes. Ann reported that it was an advisor in the PWSE who encouraged her to remain in engineering when she began to question her choice of major. Another respondent received a research internship through the PWSE.

Two of the respondents commented that they are not aware of scholarship or internship opportunities. They did not look for scholarship opportunities for this year since their grades did not meet the requirements. Dana, a third respondent, who is a freshman in ceramic engineering, stated that it is difficult for students in her major to find internships because companies do not actively recruit. She is concerned that as she competes for these opportunities she will not be considered because of her grades. She
94

says, "I didn't get one...my grades do not reflect all that I know...companies do not see that."

A resounding theme that was shared by several interview respondents and focus group participants is the perception that women who are awarded special scholarships or competitive internships receive them because of their gender, rather than their intellectual abilities. Kelly expressed concern that the reason she received an internship with General Electric is because she is a woman. She questions whether General Electric really thinks she has the skills to do the job.

Some of the respondents view the benefits of targeted scholarships and internships for women as a way to gain entrance into a competitive area. Elizabeth shared that the fact she is a woman will make it easier to receive opportunities, but once hired she must be able to compete in a predominantly male environment. She states, "we lose because when we [women] grasp opportunities they run and hide." Like several respondents, Elizabeth struggles with being given special consideration because of her gender and then dealing with the perception that she received an opportunity because of her gender and not her skills and abilities. This was a commonly expressed concern among interview and focus group participants.

Several interview respondents and focus group participants expressed concerns about organizations that exclusively provide support for women, such as the Society for Women Engineers. Some respondents expressed concerns about the negative reactions from male students who view special programs and opportunities for women and minorities as taking away opportunities for them. Some respondents view having these special organizations and programs as divisive. They would rather "work with male students than against them." Other respondents commented that having special organizations for women sends a message that women need "special support." For them
it infers that women have deficiencies that male students do not have. A third opinion of at least two respondents is that there is no discrimination against women and minorities. They believe that there are equal opportunities for men and women and that those individuals who have the ability will have access to the opportunities they want.

Mentoring opportunities for some female students in engineering appear elusive. Karen is the only respondent who is currently participating in a "mentoring" relationship with a faculty member. She worked on a research project with a faculty member during a summer internship and has continued this year. The internship was sponsored by the PWSE. She credits this experience with solidifying her interest in engineering. Dana, a senior in ceramic engineering, is a member of the Engineering Ambassador Mentor Program (TEAM), a College of Engineering program which encourages students to enroll in diverse engineering programs at ISU and does campus tours for prospective students.

The data suggest that meaningful mentoring opportunities are difficult for some women in engineering to establish. The lack of informal interaction and personal relationships with faculty were described as problems by a number of respondents. The data indicate that some women feel fortunate if a professor smiles at them, makes eye contact, says hello, or spends time answering a question. One respondent summed up her feelings on this point by saying, "some professors are receptive to students who come to their office hours....others post the solutions to class problems to avoid students coming in." Dana commented that some women in her major "don't see their professors as their friends, someone they can talk to...they would never use their professors as references." This void created by the lack of a meaningful relationship and connection with faculty compounds the problems women face in engineering by precluding the development of effective mentoring experiences. Thus, the lack of informal interaction
and sustained formal contact by faculty with women students, creates another gap in their educational experience.

When asked, "what factors have been instrumental in your academic success at ISU?, four of the nine interview respondents stated that their success was due largely to their own discipline, independence, and hard work. One respondent credited her parents' and boyfriend's support, while others reported having practical experiences through internships, labs, etc. and extracurricular activities that take the pressure off them. One focus group participant stated that she doesn't use any support services, but rather draws on her own strengths to face adversity. Another focus group participant shared that she received testing and academic support through the university after having difficulty with coursework. Jennifer was the only interview respondent who reported that she has used a tutor to help with difficult classes.

The comments related to this question indicate that some respondents feel it is ultimately up to them whether or not they succeed, so if they begin to have problems, they compensate by changing their study habits, (e.g. they study more), rather than ask for help. Reliance upon support services, such as tutorial assistance, seems a last resort for some respondents, reinforcing the notion that they should be able to handle the rigors of their major on their own.

All of the respondents reported that they are learning a lot in their major area. Jennifer found a tutor who she says was helpful. She says, "It would have been helpful to have a study partner, especially the freshman year, so I didn't feel so alone...it's intimidating to go to a professor and ask for help...they don't know you." The majority of participants in both focus groups strongly expressed the same need for a "female buddy" or partner to show them the ropes and help them become acclimated to the field.
When asked if they felt a need for a buddy in their major, the majority of interview respondents also emphatically said yes.

The most frequent complaints from interview respondents related to academic support were: (1) poor advising, and (2) difficulty understanding and working with foreign teaching assistants. Most respondents complained about receiving inadequate or ineffective advising. "In general, students across all majors complain about their advisors," stated one respondent. Several interview respondents commented that their advisors are not helpful. Shelley states, "last year my advisor didn't do a good job helping me decide what courses to take... now I have a new advisor and the less he sees of you the better he likes you." She reports that even after complaining to the chair of the department about the poor advising she was receiving, she was told that her advisor was one of the best in the department and that "this is all we can do for you." One respondent stated that students learn to rely on their professors to help them decide what courses to take, because their advisors either do not help them or they give them inaccurate information. When asked what advice she might give to young women considering engineering at ISU, Sarah responded, "don't listen to you advisor...double check everything."

Respondents who expressed concern about not being able to understand or work with foreign teaching assistants, seemed to accept that this is something they must endure and there is nothing they can do about it. So, they give up. Most respondents admit that they have never followed up with their teaching assistants to express their concerns or to let them know they still don't understand something.

Much of the interview data related to respondents' perceptions of advising in engineering, are consistent with the findings in Hewitt & Seymour's (1991) study. Negative perceptions of advising systems in science and engineering majors were also
prevalent in the Hewitt and Seymour study (1991). Major complaints from students included: advisors not keeping their office hours or discouraging students from visiting with them and advisors' lack of knowledge about course options.

Many of the focus group participants discussed internal support deficiencies in terms of a lack of basic orientation to their major and a lack of female role models. Several respondents commented that having an upperclass female student paired with new students during their first year would have been very helpful for them. An experienced partner could orient new students to the campus, advise them where to go for help, and familiarize them with the computers and other equipment they will be expected to use in their classes. Several women shared the frustrations of being in class and being asked to work on a computer assignment without ever having used the kind of computer in the class. No compensatory computer training was given in the class. Additional concerns included arriving on campus and not knowing anyone or how to get around and being expected to adjust to major life changes all at once without having anyone to help you. Feelings of isolation and not having female friends were cited as significant concerns also.

Establishing a peer network where students can meet other students, share information and "learn the ropes," was identified as a support mechanism which would be helpful to the majority of focus group participants. Other support systems identified as useful included: a tutorial assistance program in the residence halls and major specific test files for women students. According to some respondents, "male students have test files, but they are not generally shared with female students, unless you are good friends with a man."

Having more female faculty as role models in the field was cited by more focus group participants as an important support system than was cited by individual interview
respondents. Interview respondents expressed a stronger need for female peers than female faculty in their programs. In response to the question, "what would be helpful to you at this point in your academic program?," four of the nine interview respondents felt that opportunities to interact with other women would be helpful. Elizabeth suggested a class with women only with questions oriented to the experiences of women. Sarah shared that she is encouraged that her department is establishing a committee for women which is designed to address their needs. Christine, who stated that she has never had a female professor, believes that women faculty can relate better to the experiences of other women than men. Three of the nine interview respondents felt strongly that it would be helpful to them to have a professor in their department who they could talk to informally and who would demonstrate care and concern for them. The data suggest that having an interest in helping students and the ability to care are greater considerations for most respondents than whether the professor is male or female.

Summary of Data Related to Internal Support Systems

Some focus group participants clearly articulated the view that not all women in engineering want or need the same kind of support systems. However, many participants indicated a need for female role models and peer relationships with other women. Some of the participants who did not have strong female peer relationships tended to express the view that they get along better with men than with women. For some respondents the value of female peer relationships became more apparent the longer they were in their program. One participant commented, "as a freshman you are oblivious to sexism...you begin to value women friends more the longer you are in the program."
The coping strategies that many of the interview respondents and focus group participants used to enable them to overcome difficulties in their academic program, were similar to those of the survey respondents in the Hewitt & Seymour (1991) study. Two respondents indicated that they took advantage of tutorial assistance or remedial assistance programs. Other respondents indicated that they found individual professors, staff from the Program for Women in Science and Engineering, relatives and friends to provide counseling and support. The data indicate that most individual interview respondents compensate for academic difficulties by studying harder or using different study strategies, rather than seeking support systems. While several respondents expressed a need for peer networks or study groups, many do not feel they have access to existing groups. The independent, self-reliant attitude exhibited by some respondents may be viewed as a necessity by them because they do not feel that the support they need is going to always be available to them.

**Personal Fit with Major, Academic Preparation and Career Aspirations**

Questions related to personal fit with the major, academic preparation, and career aspirations, explored appropriateness of choice of major, ability of the respondents to meet the academic expectations of the major, and factors that have contributed to their persistence in their major. Individual interview questions included the following: (1) Why did you choose to study engineering?, (2) What are your short and long term goals?, (3) What expectations did you have about the engineering program before becoming a student?, (4) Have your expectations been met?, (5) Do you feel that you have been successful in your academic program?, (6) What factors have been instrumental in your success?, and (7) What do you like or dislike about your academic program?
Five of the nine interview respondents reported that they selected engineering as a major because they enjoy problem solving and being able to apply knowledge in practical ways. Four respondents were encouraged by teachers or family members to pursue engineering because they demonstrated the aptitude for math and science at an early age. They were also told that engineering is a "good, open" field for women to find lucrative jobs. Few of the respondents talked about choosing engineering to attain a specific career goal, but rather as a way to capitalize on their personal interests or intellectual strengths. All of the respondents talked about their interest in the practical application or problem solving nature of engineering as a significant factor in their decision.

During junior high or high school, all of the respondents received support or encouragement from parents or teachers that further developed their interests and skills in science and math. Most of the respondents participated in special programs for young girls in science or math, completed advanced college placement courses, became involved in school activities that promoted science or math, or experienced some unique event that piqued their interest in science or math. Elizabeth stated, "I always wanted to be a scientist...while in high school I got involved in a women in science and engineering program at Illinois Institute of Technology and learned what engineering was all about...I like the hands on aspect." Sarah's parents took her to visit different engineering schools. Shelley attended a program for women interested in engineering at ISU during her junior year in high school. Dana participated in summer internships for girls interested in engineering careers. At age 13, Jennifer took an aptitude test on careers in science at a state fair and engineering emerged as a strong career possibility. She began visiting different colleges and universities and decided by age 15 to attend ISU.
Hewitt and Seymour (1991) found in their study that among the most commonly cited inappropriate reasons women gave for going into science, math and engineering majors were: response to family pressures, materially-oriented considerations (good paying job), not knowing enough about the major, and overestimation of their skills and level of academic preparation. Hewitt and Seymour (1991) also found that family pressure is the most common inappropriate reason given by students for selecting a major in science, math, and engineering and that when the student lacks an intrinsic interest in the major or a strong vocational drive, the student's resolve to remain in the field diminishes, especially in the face of academic difficulty.

The data in this study indicate that each of the nine interview respondents experienced some type of adjustment in her attitude or expectations about her initial choice of major. Four of the nine respondents switched from one engineering major to another engineering major since they enrolled. The reasons given by the respondents for switching appear to be based primarily on the recognition that the previous major was not a good personal fit, (e.g., the respondents faced academic difficulty in some classes, lacked sufficient interest in the subject to justify meeting the demands of the major or felt unwelcome in the major). Only one respondent indicated that she is considering switching to a non-engineering major. All other respondents clearly stated that while some aspects of engineering might not be the best career choice for them, they feel that overall engineering has been a good fit for them. Arriving at this conclusion required some respondents to re-evaluate their career interests, expectations about grades and "being the best," and their personal views about the purpose of education. However, most of the respondents feel that they made the right decision. Pascarella and Terenzini (1991) contend that college students spend a considerable amount of time refocusing and refining their thinking about career options.
When respondents were asked to discuss their initial expectations of their academic program, all expressed surprise that they did not receive the good grades they had achieved in high school and several remarked that they now realize they never learned how to study. All of the respondents talked about not being prepared for the "hard, demanding" courses in engineering and that the study habits they had in high school are ineffective now. Some respondents were surprised or confused when they failed courses for the first time. Jennifer commented,

I expected to whip through engineering and not have any second thoughts about my choice of major...I wasn't aware of the weed out classes.

Dana remarked, "I expected to get A's and just blew off my classes...I had to adjust after the first semester."

Elizabeth stated, "I expected to get A's and B's and got C's...I was confused...I learned that studying for an exam the night before doesn't work anymore and that the teachers aren't going to remind you."

After receiving average grades her first year, one respondent talked about reconciling with herself that she would not receive the A's and B's she received in high school, which caused her to rethink what getting an education is all about. She states, "now I realize that education teaches you processes for thinking and learning that you can then apply in other situations." She has taken some of the pressure off herself to be an A student, as have many of the respondents.

Some respondents expressed a need for more structure from faculty, especially during their first year. For example, several respondents said that they like the professors who give and collect homework because it gives them and their professors a way to regularly assess how they are doing. One respondent commented that she wished her teachers had stayed behind her and pushed her to do better during her first
year. It becomes clear after listening to some of the respondents that a better balance of challenge and support during the first year would have helped some respondents make the difficult transition to college where students are completely responsible for their own success or failure.

Despite lower than expected grades the first year, all of the respondents indicated that they feel successful in their academic majors overall. When asked what they liked most about their academic programs, all of the respondents indicated that they like the content of their major courses, especially those which teach practical applications. This finding supports Hewitt & Seymour's (1991) thesis that an intrinsic interest in the subject matter is an important persistence factor. Despite concerns about lack of faculty interaction and support, limited positive peer relationships, few female role models, poor advising, and demanding course loads, most of the respondents have decided that it is worth the pressures they experience to get a degree in engineering.

Some respondents complained about the load and demands of engineering, but did not cite these as reasons that would cause them to switch into non-engineering majors. It appears that the intrinsic interest in engineering and the motivation of the respondents to be independent and tenacious, may cause some of them to match the challenges (demanding classes, etc.) they face with even greater efforts (studying more, adjusting expectations, etc.). To some extent, their accomplishments seem to be enhanced by their ability to continually meet the demands imposed upon them within their major.

Perception of Self in the Field

One observation from the data is that most of the women who were interviewed do not view themselves as "typical females." For example, Elizabeth commented, "you
can't be a typical female and be an engineer." To further examine this perception, it is necessary to consider the sequence of influences and experiences that the respondents described as helping to get them where they are today. The data show that most of the respondents have usually (1) excelled academically in school, (2) been promoted by parents and teachers (3) told that they are special or gifted, (4) been selected to participate in highly selective pre-college programs, and (5) have survived the challenging "weed out" courses in college that many males and females flunk. Therefore, there seems to be an obstinate belief on the part of some respondents that they can succeed at anything they attempt to do and that their success is due to their own intellectual abilities, independence, hard work, and determination. Several respondents expressed feeling that these are the characteristics that separate them from the "average" women who do not succeed in this field. There appears to be a strong need on the part of some of the respondents to be viewed by their professors and other students as competent, high achieving, independent, and self-motivated students. Comments from some respondents indicate that any suspicion that a woman got good grades because she smiled at the professor a lot or flirted with him, is viewed by male and female students with disdain and questions are raised about her intellectual abilities. It is important to most of these respondents that other women earn what they get honestly.

Five of the nine respondents plan to pursue a master's degree or MBA after graduation. These respondents indicate that they believe it will be essential for them to have a master's degree if they want to "move up in management" or "get on the fast track." According to Elizabeth, who plans to get a master's, "men don't need a master's... they get picked first for management...we are conditioned to not think of a woman to be the boss...men have a problem with that." Christine wants to work in a "humanitarian role," perhaps with the Peace Corps. Kelly wants to get a master's degree
in environmental engineering and then attend law school. Her long term goal is to practice environmental law.

None of the respondents indicated an interest in research or teaching in their major. Most have indicated an interest in working in private industry. All respondents expressed a desire to work in jobs where they can use their technical knowledge in practical ways.

Preferred Teaching and Learning Styles and Methodologies

"In considering how to design an education appropriate for women, suppose we were to begin by simply asking, "what does a woman know?" Traditional courses do not begin there. They begin not with the student's knowledge, but with the teacher's knowledge" (Belenky et al., 1986, p. 198). By raising this question, Belenky et al (1986), suggest that traditional courses are based on the questions that emanate from their male-dominated culture and that female students may have different questions since they have had little to do with developing the agendas and culture of traditional disciplines. Therefore, questions about what women feel they need to know and how they best learn remain unanswered for many women.

To further investigate "women's ways of knowing," (Belenky et al., 1986, p. 3), the following questions were asked individual interview respondents to better understand their preferred teaching and learning styles and methods in engineering:

(1) What types of learning experiences have been most helpful or least helpful to you in your academic program?, (2) How would you describe the teaching styles and methods of your professors?, (3) In what ways are your professor's teaching styles and methods conducive to your particular learning needs and interests?, (4) Do you feel that your professors are aware of you learning needs and interests?, (5) Do they make an attempt
to adjust their styles to meet your needs?, and (6) What are the most effective teaching and learning strategies for you?

In response to the question about what learning experiences have been most helpful, the respondents related their comments to the nature of their classes and relationships with faculty and peers, rather than their professors' teaching styles and methods. Among the most helpful learning experiences shared were: labs or classes which provide practical experience, recitations, and small interactive classes. One to one interaction with the recitation teacher, teaching assistants and professors was helpful for five of the respondents. Some respondents surmised that having a relationship with one's teacher is important, especially if you are having problems in the class. Personal contact assures that, "you are not just another face in the class," one respondent commented. Another respondent expressed the importance of having a network of women in your academic program to support and encourage women in engineering majors. One respondent shared that her freshman engineering classes were helpful to her and another remarked that having tests that measure practical knowledge were helpful.

The majority of respondents expressed feeling that large lecture classes are the least helpful to them because of the impersonal nature and the lack of practical application. Some respondents are annoyed by professors who write information on the board that can be found in the textbook and view this as a waste of time. One respondent stated that professors do not spend time finding out what students learn. According to Kelly, "most students never open a book...they learn everything from the teacher."

In describing their professors' teaching styles, the responses included comments such as,
professors don’t care, most are here to get their research done...to get money for their research they have to teach...most professors go through the formality of beginning class by asking if there are questions...they don’t really expect any and are shocked when they get them...professors have their own way of doing things and expect students to adjust...I’ve never had a professor ask what I wanted...and, some professors are receptive to questions, but often aren’t caught up so they don’t ask.

Most of the responses to the question about helpful learning experiences related to how the professors made the respondents feel, rather than an assessment of the specific methods the professors use to conduct the class.

When asked what is the most effective teaching strategy for you, five of the respondents mentioned that it is most helpful to see the professor work through class problems on the chalkboard or to work through the problems outside of class. Most of the respondents indicated that they learn best by seeing examples. One respondent pointed out that, "teaching styles are geared to men because its [engineering] a traditional men's field...men don't complain about lecture classes...men say tell me how and I can do it, whereas women say show me how and I can do it."

The respondents' preference for learning by example, is consistent with findings from Belenky's et al. (1986) study. According to Belenky et al. (1986), most of the women they interviewed named experiential learning as the most powerful learning strategy for them and that their knowledge comes most easily from first hand observation and not abstract teaching. Structured learning experiences were helpful for interview respondents and participants in the Belenky et al. (1986) study. For example, some interview respondents prefer that their professors give and collect homework and hold students to greater expectations about what they should learn.

Interview respondents for this study described their learning experiences in terms of how the academic environment and relationships with faculty and peers shape their
learning. At this time, there appears to be no expectation on the part of most respondents that there is any other role for them in the learning process other than collecting and compartmentalizing bits of information to be recalled later (e.g. tests, labs, internships, etc.) Nor is there an expectation that faculty should make an effort to adjust the way they teach to accommodate differing styles and needs. One respondent commented that professors should not have to make students comfortable. Another responded that the way professors conduct classes is the most efficient way to teach hundreds of students in a class.

When asked if they felt professors would be open to suggestions about their teaching styles, several respondents viewed this a taking huge risk. The one respondent who expressed concerns she had to a professor about his teaching did not indicate that she experienced repercussions. However, there seems to be an unspoken acceptance of that fact that students who challenge professors put themselves at risk in the program.

The respondents' reactions to the teaching styles of female teachers indicate that the expectations for female teachers are different than for males and that at the same time female teachers are held to some male standards of decorum in the classroom. No specific comments were made about female faculty's knowledge of the subject or teaching methods, rather comments about female faculty related to their interpersonal interactions with students. One respondent remarked that she has had two female faculty and enjoyed them. She says, "I prefer their tone of voice and patience...some guys do to."

Another respondent who has had one class with a female teacher said that she saw no recognizable difference in her teaching approach compared to male teachers but, she found the female teacher annoying because she spoke so softly. A third respondent also commented that she found a female teacher she had for a class to be unassertive,
"too soft spoken." When asked if she ever gave the female professor constructive feedback she replied, "I would never approach her because she would have been insulted. I would have said something if I thought she could handle it." She rated her the least effective of all her teachers. In contrast, when asked the same question about her male faculty, this respondent shared that she had approached a male professor after class to say that she was confused and did not find the class session helpful. As she put it, "the professor and students were shocked." Her perception was that the male faculty member could handle the feedback. Another respondent said that she would be concerned about any female faculty member who came into her department because of the way she would be treated. Her perception was that a female could not handle the differential treatment she would experience. Two respondents described professors who they found to be more patient than others when explaining things to women. One states, "they know we lack self-confidence so they adjust their tone of voice." Another respondent reports, "he explains things more thoroughly to the women in the class than he does for the men...the men complain."

Some of the respondents' attitudes about female faculty perpetuate stereotypes about women that are often attributed to males. The data suggest that for some of the respondents it is unacceptable for a woman in engineering to be timid or unassertive. For example, women faculty who are "soft spoken" appear too fragile to hear and respond appropriately to constructive criticism and are perceived as unable to deal with differential treatment in the workplace. Also, women who do not present themselves as strong and forceful are considered ineffective by some respondents, regardless of their knowledge or teaching effectiveness.
Summary of Data Related to Preferred Teaching and Learning Styles and Methodologies

The data suggest that some women begin the learning and thinking process from their own personal experiences and that they are taught to accommodate existing structures (Belenky et al., 1986). This thesis places the question about what women need to know and how they are best taught in perspective for engineering and other male-dominated disciplines. The data from this study indicate that some women prefer to learn things for which there is practical application and that learning in small, interactive classes is preferable to large, impersonal lectures. Some women indicate that their learning is enhanced when they can observe and experience the subject matter and have an opportunity to hear the experiences of others as well as have their own experiences heard by professors and peers. Consistent with the findings of Belenky, et al. (1986), is that most interview respondents, while clearly capable of abstract thinking and reasoning, prefer concrete learning experiences, especially when the subject matter is not out of their own personal experiences. This approach adds to their comfort and confidence.

Supportive formal and informal relationships with faculty is also a significant factor that some women feel would enhance their academic experience in engineering. One interesting finding is that the attitudes of some respondents about the difference between female and male professors' teaching styles, indicate a preference for female faculty who demonstrate interpersonal characteristics generally attributed to male faculty (e.g., forcefulness in presentation). This finding indicates that some women in engineering perceive the most effective female role models in engineering are those who exhibit masculine interpersonal characteristics.
Description of Survey Data

The researcher was provided access to selected data collected from a survey of undergraduate women in engineering majors at Iowa State University. The survey was conducted by the Program for Women in Science and Engineering as part of a program evaluation to assess its effectiveness in meeting its goals and objectives.

The researcher extracted selected data from the survey responses as a supplement to this study. Of interest to the researcher were supplemental data related to (1) classroom climate, (2) internal support, and (3) personal fit with the major, academic preparation, and career aspirations. The researcher participated in the development of survey questions related to these areas. These areas are consistent with the general research objective identified in Chapter One. The section begins with a description of the survey sample and concludes with a descriptive summary of the survey responses. Survey responses are grouped and described within the theoretical constructs or themes established in Chapter One and further explained in Chapter Three.

Description of Sample

The total population of undergraduate women in engineering majors was 465. The total population of all women in science and engineering majors was 1,632. The survey sample consisted of 200 undergraduate women who are majoring in various engineering disciplines at Iowa State University. The total number of responses was 96 (48%). The sample was taken by random stratified sampling. Selected demographic data for the sample are presented in Table 4.

Sampling and data tabulation were completed by researchers in the office of the Program for Women in Science and Engineering. Because of the low number of women in some engineering majors, weighted averages were used in tabulating data for some
survey responses. Weighted averages were used for tabulating the data reported in the following discussions of classroom climate, internal support, and personal fit with the major.

Of the respondents who answered, 66 are from Iowa and 22 are from other midwestern states. Of the 465 undergraduate engineering majors at ISU, the largest enrollments are in Industrial and Mechanical Engineering with 34% (N=157) and Materials and Science Engineering with 22% (N=102). The lowest enrollments are in Engineering Operations and Nuclear Engineering with 0.2% (N=1) each.

Nearly 63% (N=60) of the survey respondents have been at ISU for 3 or more semesters. Ninety-two percent (N=88) of the respondents are between the ages of 17-23. Nearly 37% (N=34) of the respondents reported a cumulative grade point average of 3.00-3.49, while nearly 15% (N=14) achieved grade point averages of 3.50-4.00.

Respondents were asked to indicate who encouraged their choice of engineering as a major. Multiple choices were possible. Eighty-six percent (N=85) of survey respondents reported that they selected engineering as a major because of the influence of a family member, while 54% (N=52) said they were influenced by a friend or fellow student.

Table 4. Selected demographics from survey sample

<table>
<thead>
<tr>
<th>Major Area</th>
<th>Population (N)</th>
<th>Sample (n)</th>
<th>Responses (R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture &amp; Biosystems</td>
<td>6</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Aerospace &amp; Engineering Mechanics</td>
<td>31</td>
<td>20</td>
<td>7</td>
</tr>
<tr>
<td>Civil &amp; Construction Engineering</td>
<td>74</td>
<td>31</td>
<td>15</td>
</tr>
<tr>
<td>Materials &amp; Science Engineering</td>
<td>102</td>
<td>42</td>
<td>17</td>
</tr>
<tr>
<td>Electrical &amp; Computer Engineering</td>
<td>66</td>
<td>27</td>
<td>18</td>
</tr>
</tbody>
</table>
Table 4. (Continued)

<table>
<thead>
<tr>
<th>Field</th>
<th>First Group</th>
<th>Second Group</th>
<th>Third Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial &amp; Manufacturing Engineering</td>
<td>157</td>
<td>50</td>
<td>28</td>
</tr>
<tr>
<td>Engineering Operations</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Nuclear Engineering</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Pre-Engineering</td>
<td>24</td>
<td>19</td>
<td>7</td>
</tr>
<tr>
<td>Pre-Engineering Science</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>465</strong></td>
<td><strong>200</strong></td>
<td><strong>96</strong></td>
</tr>
</tbody>
</table>

2. Semesters at ISU:  
   - 1 to 2: 35  
   - 3 to 4: 22  
   - 5 to 6: 16  
   - 7 to 8: 15  
   - 9 or more: 7

3. Grade point average:  
   - Less than 2.0: 3  
   - 2.00 - 2.49: 12  
   - 2.50 - 2.99: 29  
   - 3.00 - 3.49: 34  
   - 3.50 - 4.00: 14  
   - No response: 3

4. Encouraged choice of major: (more than one choice)  
   - Family member: 85  
   - Friend or fellow student: 52  
   - Teacher or counselor: 59  
   - Other adult: 41  
   - Professor in desired major: 29  
   - Other: 3
Table 4. (Continued)

<table>
<thead>
<tr>
<th>5. Age:</th>
<th>N=</th>
</tr>
</thead>
<tbody>
<tr>
<td>17 - 23</td>
<td>88</td>
</tr>
<tr>
<td>24 - 29</td>
<td>3</td>
</tr>
<tr>
<td>30 - 39</td>
<td>3</td>
</tr>
<tr>
<td>40 or more</td>
<td>1</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>6. Home state:</th>
<th>N=</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iowa</td>
<td>60</td>
</tr>
<tr>
<td>Illinois</td>
<td>9</td>
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<tr>
<td>Nebraska</td>
<td>5</td>
</tr>
<tr>
<td>Missouri</td>
<td>3</td>
</tr>
<tr>
<td>Minnesota</td>
<td>5</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
</tr>
</tbody>
</table>

(Program for Women in Science and Engineering Survey, 1992)

Survey Questions: Classroom Climate

To assess the respondents' attitudes and perceptions about the educational environment for women in engineering they were asked to (1) answer short answer questions and Likert-type items which relate to uncomfortable experiences they have had in their academic programs and perceived reasons for the disproportionately low number of women in science, mathematics, and engineering fields, (2) indicate the degree to which they believe certain identified factors contribute to the under representation of women in science, engineering, and mathematics, and (3) identify and rate those factors that have been a problem for them in their academic program (see Appendix G).
From the collected survey data, the researcher isolated five themes that were identified by the respondents as negative climate factors or problems in the educational environment. These themes include: (1) competitive atmosphere in technical classes, (2) discriminatory and sexist attitudes toward women on the part of teachers or others in technical fields, (3) lack of encouragement from college faculty and advisors, (4) the view that women in technical fields are unfeminine, and (5) limited opportunities to join informal study and social support groups with other students.

The data related to these themes are described below. Selected survey responses were grouped and discussed according to the relevant themes identified in the preceding paragraph. Two key questions served as the basis for discussion and analysis of the survey data. First, a two part question related to the above themes, asked respondents to indicate to what extent they believe 19 selected factors have contributed to the under representation of women in technical fields. Response choices were, NONE, SOME, and A LOT (see Appendix J). The frequencies for selected factors that respondents indicated have contributed SOME or A LOT are provided in the description that follows. The second part of the question requested respondents indicate by circling YES or NO, if the factor has been a problem for them (see Appendix K). Selected frequencies above 7% are reported.

Secondly, a short answer question asked respondents, "While at ISU, have you had any uncomfortable experiences in your academic program? If yes, please specify." Selected individual responses related to this question are discussed along with responses related to the two part question about factors which have contributed to the under representation of women in technical fields.
Competitive Atmosphere

In response to the question, "What do you think has contributed AT LEAST SOME to the under representation of women in technical fields?," 45% (N=43) of the respondents reported that the competitive atmosphere in technical classes has contributed A LOT and 46% (N=43) said they believe it has contributed SOME. In response to the question, "have any of these factors been a problem for you?" 33.7% (N=32) of the respondents indicated that the competitive atmosphere of technical classes has been a problem for them. When asked to report on "uncomfortable experiences in your academic program while at ISU," one survey respondent commented, "I don't think the curving of grades is fair and American students are not very willing to help other students."

Discriminatory and Sexist Attitudes

Thirty-five percent (N=32) of survey respondents indicated that they believe discriminatory attitudes toward women on the part of teachers and others have contributed A LOT to the under representation of women in technical fields, compared to 49% (N=48) who believe this factor has contributed SOME. Approximately 30% (N=28) of the respondents indicated that they have had problems with discriminatory attitudes by teachers or others in technical fields.

In response to the question, "Have you had any uncomfortable experiences in your academic program while at ISU?," six of the survey respondents reported that they experienced or perceived bias against women from professors. One respondent reported that "her major professor was biased against women and took every opportunity to undermine her work." Other reports include: "my instructor would not check my work,"
but he checked all of the other students (all men);" "professors are prejudiced towards the female sex;" and "some professors believe women are inferior."

In response to the short answer question, "while at ISU have you had any uncomfortable experiences in your academic program?, " 45 individual responses demonstrated that some women in engineering have had negative experiences or have perceived a negative environment or lack of support. Respondents primarily reported or alluded to a wide range of overt attitudes and subtle behaviors that made them uncomfortable, rather than overt physical behaviors. There were no clear reports of physical intrusion reported by any respondent. While one respondent reported that she was "harassed by teachers and students," it is unclear what the nature or extent of the harassment was.

Among comments from other survey respondents on this short answer question were: "instructors are sexist;" "I have had at least two professors make sexist comments to me;" and, "jokes are told about women that are degrading." One anecdotal comment reported was a statement made in class by a professor in which he, "called a substance abbreviated NAG, a female enzyme...actually it's a female substrate." Reports were received from two respondents in which they said they were, "insulted by teachers and made to feel dumb." One respondent reported displays of discomfort from male members of an engineering honor society when females joined."

Most of the comments were generalized, making it difficult to determine the specific nature and extent of behaviors that made some respondents uncomfortable. However, it is clear that nearly half of the respondents have perceived or experienced negative attitudes or other undesirable treatment in engineering programs, some of which they clearly relate to gender differences.
Lack of Encouragement

Nearly fourteen percent (N=14) of respondents reported "lack of encouragement from faculty and advisors" as contributing A LOT to the under representation of women in technical fields compared to 48% (N=46) who indicated it has contributed at least SOME. Lack of encouragement by faculty and advisors was also cited as a problem experienced by 11.7% (N=11) of respondents.

View of Women

Twenty-six percent (N=25) of respondents felt that "the view of women in technical fields as unfeminine" has contributed A LOT to the under representation of women in technical fields, compared to 49% (N=48) who believe this view has contributed SOME. Fewer than 5% (N=5) reported that this factor has been a problem for them.

Another environment factor which was cited as contributing A LOT or SOME to the under representation of women in technical fields is "the view that scientists are cold and impersonal" with 12% (N=11) reporting A LOT and 41% (N=39) reporting it has contributed SOME.

Limited Peer Support

Nearly 51% (N=47) of the respondents reported that the "lack of contact with women in scientific fields" has contributed A LOT to women's under representation in technical fields, compared to 47% (N=46) who believe it has contributed SOME. When asked, "which factors have been a problem for you?" over 48% (N=45) of the respondents indicated that lack of contact with women in the field has been a problem for them.
Seven percent (N=7) of respondents indicated that they believe "limited opportunities to participate in informal study and social groups with peers" has contributed A LOT to the under representation of women in technical fields, compared to 44% (N=41) who indicated that it has contributed SOME. Approximately 20% (N=19), expressed having problems with limited opportunities to join informal study or social groups with others students.

Survey Questions: Internal Support

To assess respondents' perceptions of the availability and quality of formal and informal support for women in engineering they were asked to answer open-ended questions and Likert-type items related to the availability and effectiveness of internal support in their fields (Appendix G).

Lack of Career Information

In response to the question, "what do you think has contributed AT LEAST Some to the under representation of women in technical fields?, 47% percent (N=46) of respondents reported that "lack of information about careers in science fields" has contributed A LOT and 44% (N=41) reported it has contributed SOME. Nearly 32% (N=30) reported a lack of information about careers in their fields has been a problem for them personally.

Limited Internship Opportunities

Thirteen percent (N=13) of respondents indicated that they believe limited opportunities for meaningful internships has contributed A LOT to the under representation of women in technical fields, while 38% (N=38) believe this factor has
contributed SOME. Twenty-five percent (N=23) of respondents indicated that limited opportunities for meaningful internships in their fields has been a problem for them.

**Limited Formal and Informal Interaction with Professors**

Also, limited opportunities to participate in informal groups with professors was reported by 9.3% (N=9) of respondents who felt it has contributed A LOT to under representation of women and 47% believe it has contributed SOME. Twenty-six percent (N=24) have experienced limited informal interaction with faculty as a problem. Limited mentoring experiences were viewed as a problem for 32% (N=29) of survey respondents. Nearly 19% (N=18) responded that limited mentoring experiences have contributed A LOT to the under representation of women in technical fields, while 53% (N=51) indicated this factor has contributed SOME.

Respondents also reported as problems the lack of encouragement from faculty and advisors (11.7% or N=11); limited opportunities to participate in formal research (16.5% or N=16); limited opportunities to advance in the field (12.% or N=12). and lack of encouragement from teachers and counselors in high school. (20% or N=19).

**Inadequate Advising and Counseling**

Thirty-four percent of respondents (N=33) reported that inadequate academic advising has contributed A LOT to the under representation of women. Nearly 41% (N=38) felt that it has contributed SOME. Thirty-six percent (N=34) of the respondents reported inadequate academic advising and career counseling has been a problem for them.
Uncomfortable Experiences Related to Internal Support

When asked to report on uncomfortable experiences they have had in their academic program, among the 45 short answer responses related to internal support were the following: "being the only woman in an electrical engineering class is rather intimidating...other than that my time at ISU has been very positive" and "we need more women and women professors; sometimes it seems unnecessarily unbalanced."

Other respondents reported a lack of interest by some faculty in students' progress and an unwillingness by faculty and advisors to help students. One respondent commented, "I can't believe a school with such a respected reputation can have such awful professors who are unwilling to help students!" "Poor advising" and poor peer relationships during the freshman and sophomore years were cited by a number of respondents as making them uncomfortable. It is unclear what the nature or extent of the problems are. Another respondent stated, "counselors didn't work with me to see my strengths and weaknesses in planning my first semester." One other reports, "my advisor is not well-informed about what needs to be done." At least five respondents cited as a problem the difficulty understanding and developing relationships with foreign teaching assistants.

Other internal support factors which were identified by the respondents as being a problem for them include: limited opportunities to participate in informal groups with professors (26%, N=24); and limited opportunities for internships in the field (25%, N=23).
Survey Questions: Personal Fit with Major, Academic Preparation and Career Aspirations

Survey questions related to personal fit with the major, academic preparation, and career aspirations asked the respondents to identify (1) reasons for their choice of major, (2) why they chose to attend Iowa State University, (3) academic standing, and (4) factors that have been problems or have made them uncomfortable in their academic programs.

The respondents were asked to identify the reasons they selected their field of study from a list of ten items. The respondents were allowed to select more than one response from the list.

Reasons for Choice of Field

The highest percentage of engineering responses (86% or N=83) indicated respondents selected their major because of personal enjoyment or interest in the field. Eighty-percent (N=77) cited "good pay" and 79% (N=76) cited availability of jobs as major reasons. Prestige of the field was ranked fourth with 73% (N=70). Sixty percent (N=58) of responses indicated respondents selected their major because of its importance for preparation for their intended careers and 54% (N=52) cited personal talent in the field of study.

Reason for Attending ISU

When asked why they chose to attend ISU, the top five reasons given by respondents included: reputation of the department (68% or N=65), followed by location (56.2% or N=54) and reputation of ISU (56.2% or N=54), availability of
desired major (54% or N=52), and cost (48.9% or N=47). Quality of campus life was given by 20.8% (N=20) and financial aid was identified by 22.9% (N=22).

**Persistence by Semesters**

Nearly forty percent (N=38) of respondents have persisted at ISU for five or more semesters. Twenty-three percent (N=22) have persisted for three to four semesters.

**Grade Point Averages**

Of the 92 respondents reporting grade point averages, the data indicate that 52% (N=48) have achieved a grade point average of 3.00 to 4.00, while 32% (N=29) have achieved an average of 2.50 to 2.99.

**Personal Fit**

The responses related to personal fit indicate that 9% of respondents (N=10) believe that the long years of formal preparation required of engineering majors has contributed A LOT to the under representation of women in technical fields, compared to 64% (N=58) who believe this factor has contributed SOME. Nearly 42% (N=40) indicated that possible conflicts between career and family has contributed A LOT, while 52% (N=49) believe this factor has contributed SOME.

**Summary of Survey Data**

The selected survey data suggest that some undergraduate women in engineering are experiencing problems in the educational environment. Nearly half of the survey respondents reported experiences in their academic programs that have made them
uncomfortable. Behaviors and attitudes reported by survey respondents include sexist comments and jokes about women, comments from professors that have made some women "feel dumb" in class and "harassment by professors and students."

Among the major factors respondents identified that have created problems for them in their academic program are: lack of contact with women in the field, lack of information about careers in scientific fields, limited mentoring experiences, inadequate academic advising and counseling, the competitive atmosphere in the classroom, discriminatory attitudes toward women by teachers and others in technical fields, possible conflicts between career and family, and women's lack of confidence that they can do the work. The data indicate that most respondents adapt to the environment in engineering rather than challenge it.

Factors reported by 34% or more of respondents as having contributed a LOT to the underrepresentation of women in technical fields include: lack of contact with women in the field (51.3%), lack of information about careers in scientific fields (46.8%), competitive atmosphere in the classroom (45%), lack of encouragement from teachers and counselors in high school (44.6%), women's lack of confidence they can handle the work (42.3%), possible conflicts between career and family (41.4%), inadequate academic advising and counseling (34%), and discriminatory attitudes toward women by professors and others in technical fields (34%).

The data also indicate that despite problems some women are experiencing in their educational environment, including limited internal support, discriminatory or sexist attitudes and behaviors, or concerns related to family and career conflicts with their majors, many women are achieving and maintaining strong academic standings. The data show that nearly 84% (N=77) of respondents reporting grade point averages, received a 2.50 or better.
Reasons most respondents gave for choosing engineering as a major indicate they possess an intrinsic interest in the field. This finding bodes well for women who enter engineering for this reason as opposed to pressures from family or financial considerations. Hewitt and Seymour (1991) found that students who enter science, mathematics or engineering fields primarily for reasons other than intrinsic interest or a strong vocational drive, may increase the odds of later switching to other majors. This is especially true if they begin to experience difficulties in the major. The combination of personal interest and motivation to pursue engineering and a sound academic standing may enhance the persistence of some women in engineering majors.

Summary of Findings

The findings delineated in the previous section of Chapter Four present the perceptions and experiences of undergraduate women in engineering majors at Iowa State University. Relevant theoretical constructs or themes which frame the discussion of the findings include: classroom climate, interaction with faculty and peers, internal support systems, personal fit with the major, academic preparation and career aspirations, and preferred teaching and learning styles and methodologies. A summary is provided in this section of newly emergent themes and related findings.

Classroom Climate

A significant number of interview respondents, focus group participants and survey respondents shared experiences and perceptions that substantiate the existence of a negative educational environment for women in many engineering majors. Data from a combination of qualitative and quantitative responses indicate that classroom climate issues are prevalent in engineering majors. At least one-half of the survey respondents
reportedly experienced attitudes or behaviors exhibited by faculty or peers, that made them uncomfortable. A total of 45 engineering survey respondents, as well as several interview respondents and focus group participants, reported biased, sexist, or differential treatment they have experienced from faculty or peers in their programs. Among the incidents reported were biased or discriminatory behavior directed toward women, harassment by professors and students, condescending attitudes toward women, and sexist jokes and demeaning comments about women. This finding illustrates that a substantial cross section of undergraduate women in engineering majors have experienced negative attitudes or behaviors in their program that appear to be related to gender.

A major finding of this study is that most of the interview respondents try to adapt to the environment in engineering. Some respondents indicated that they have experienced no environmental problems in their academic program. However, some descriptions of their observations and experiences seem to indicate that they have observed, experienced, or become aware of differential treatment of women. It is evident that some women do not feel that it is safe to report cases of harassment, discrimination or differential treatment. Rather, some women choose to remain silent in the classroom even though they may have something to say. Some women alter their behavior to avoid being perceived as flirtatious with male faculty and peers. Some women also choose not to meet male faculty in their offices for help with class problems out of fear that their presence will be perceived as an invitation or that they are using their gender to solicit good grades.

Another noteworthy finding is that interview respondents were found to participate less actively in class sessions than male students. The data indicate that some women feel unprepared and uncomfortable in engineering or science classes,
because they have not had the practical exposure to scientific and technical concepts that some male students have had. In the perception of many interview respondents, male students are better prepared entering the field and are more likely to receive the attention of professors because they are more knowledgeable. These "gaps in learning," that some women say they experience, may exacerbate feelings of low self-esteem and lack of self-confidence, especially in young women just entering college. This lack of self-confidence may preclude women students from offering their opinions and ideas or asking questions, for fear of being perceived as incompetent or "dumb."

Another finding from the data is that some women in engineering majors believe that professors have lower expectations for women in their classes than they do for men. As reported by some respondents, professors are less likely to call on female students to comment or to answer questions in class, especially if the questions are difficult. Some respondents view this as enabling women students not to prepare for class, since they feel assured that they will not be called on to respond. In addition, if professors have low expectations for women's participation in class, they do not allow them the opportunity to develop skills and competencies they reportedly lose upon entering college (i.e., loss of self-esteem, self-confidence, reluctance to speak in public, Hafner, 1989).

**Interaction with Faculty and Peers**

Lack of interaction with faculty and peers in their major caused some respondents and focus groups participants to feel excluded, alone and unsupported. It was important for many interview respondents to be able to know and develop meaningful relationships with their professors and peers. The lack of "connection" with faculty, in particular, left some respondents feeling discouraged and that no one cared
about them or whether they made it through the program. This absence of "support and
caring" by their teachers was a radical departure from the attention that many
respondents received from parents and teachers while they were in high school. All
respondents reported struggling during the first year to adjust to poor or average grades,
lack of structure and follow up by professors, and being completely responsible for
themselves. This finding supports the need for sustained formal and informal
relationships between women students and faculty, especially during the initial years
they are in their majors. In addition, positive faculty interactions may inspire positive
peer interactions, which have also been found by some research studies to positively
affect student's educational aspirations (Pascarella & Terenzini, 1991).

Internal Support Systems

The data indicate that most interview and focus group participants are not
systematically linked to internal support systems, which could provide information on
internship and scholarship opportunities, advice and counseling, or tutorial and remedial
assistance. Most respondents have only a general idea of where to go for help with
internship and scholarship opportunities. Awareness of the support and assistance
offered by the Program for Women in Science and Engineering was limited in most
cases. The few respondents who reported that they have used support programs from
the PWSE said that they found the office staff helpful in providing advice and
counseling, career planning assistance, and in finding internships.

Another finding is that few of the respondents or focus group participants use
support systems, such as tutorial or remedial assistance. Most respondents reported that
they draw upon their own strength and abilities when they need help (e.g., they study
harder, study with another student).
One finding that demonstrated confusion on the part of some respondents is related to programs and organizations that are designed to support women in science and engineering majors. Some respondents are opposed to programs, such as the Society of Women Engineers and the Program for Women in Science and Engineering, because they perceive them as divisive ("males complain that they represent reversed discrimination and become angry with women"), they "send messages that women need special support with their deficiencies," and that they are unnecessary because there are equal opportunities for men, women and minorities who have the ability to compete. Ironically, at least one interview respondent, who is receiving a full ride scholarship for women, says she is strongly opposed to them because they are unfair and vows she will fight against them once she graduates.

**Personal Fit with Major, Academic Preparation, and Career Aspirations**

The data indicate that approximately one-half of the interview respondents selected engineering as a major based on intrinsic interest in the subject, while the remaining one-half selected engineering because of parental influence. All of the respondents entered college with strong academic records, especially in math and science. Despite poorer than expected grades the first year, the demands of an intense field, feeling a lack of support from faculty and peers, and poor advising, the majority of respondents feel that they are doing well academically and intend to remain in engineering. Most respondents have recognized that they will not earn the good grades they received in high school and have resolved that is ok if they can maintain an academic standing that will enable them to remain in their programs.

Although one-half of the respondents indicated that they selected engineering as a major because of parental influence, they also seem to have sufficient interest in the
subject to continue in the field despite adversity. Several of the interview respondents intend to get a master's degree in engineering in the future. All except one respondent plans to work in private industry upon graduation.

**Preferred Teaching and Learning Styles and Methodologies**

The findings of the study related to preferred teaching and learning styles, show that all interview respondents prefer to learn in small, interactive classes or labs, rather than large lecture classes. A common complaint about lecture classes is that there is no opportunity for meaningful interaction with the professor or other students. It is supported by the data that the most effective learning strategy for most of the respondents is the use of concrete examples. Most respondents indicated that they learn concepts better when they can see them, in addition to hearing the explanation about them. The data indicated that small, interactive group discussions or projects focused on specific practical concepts that students would be asked to apply to some situation, would be more effective for women students than large lecture classes. Faculty could respond to this learning style preference by utilizing cooperative learning approaches, such as small group discussions or projects, within the lecture class session.

The data suggest that an important consideration for many interview respondents is that they have an opportunity to get to know their professors. Those professors who do not take the time to get to know students, or demonstrate that they care, were regarded as ineffective teachers by most respondents. Their assessment of teaching effectiveness was based on the personal interactions of the professor, rather than his or her teaching methods.

The data clearly demonstrate that most interview and focus group respondents would prefer to have more female peers in their major for support. However, the
attitudes of some respondents regarding female faculty, indicate that the presence of female faculty who do not fit the image of an "engineer" may not bring a positive difference to the classroom for them. Female faculty who are perceived as weak, timid or unassertive are not viewed as positive role models by some respondents. They are also not viewed as effective teachers by some, although none stated that they had problems with the knowledge female faculty possessed about the subject or their teaching methods. Only one respondent indicated that she felt there would be a positive difference in the classroom environment if more teachers were female.
CHAPTER FIVE
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Introduction

In this chapter the researcher presents a summary of the findings of the study, conclusions, and recommendations for future research. Using the theoretical constructs identified in Chapter One, the researcher will discuss major findings and concluding hypotheses. In addition, a discussion of the relationship of these data with related research will be provided.

The purpose of this study was to describe and analyze the perceptions and experiences of selected undergraduate women in engineering majors at Iowa State University. Based on a review of related literature, three central questions provided direction for the study. These were: (1) What key factors within the educational environment influence the enrollment and retention of undergraduate women in engineering majors at Iowa State University? (2) In what ways do these factors influence the choices women make in pursuing their educational goals?, and (3) How do women view their educational experiences in engineering in light of the expectations they had upon entering their chosen field of study? From these questions, the researcher focused the study on selected educational environment factors that may affect the recruitment and retention of women in engineering majors. The factors or theoretical constructs which provided the focus for the study included: classroom climate, interaction with faculty and peers, and internal support systems. Related constructs that were examined included: personal fit with the major, academic preparation, career aspirations, and preferred teaching and learning styles and methodologies. Data related to these constructs were examined to determine their impact on the career choices and decisions made by undergraduate women in engineering.
Summary and Conclusions

This study was based on the use of qualitative research methods to generate data related to selected educational environment factors that may affect the enrollment and retention of women in engineering majors. Supplementary data were collected using survey data and document analysis.

Semi-structured individual interviews were conducted with nine female undergraduate engineering majors. In addition, two semi-structured focus group discussions were held with female undergraduate engineering majors. The interviews and focus groups were designed to elicit first hand information about the respondents' perceptions and experiences related to selected educational environment factors in their majors.

The data were categorized and analyzed according to relevant theoretical constructs related to educational environment. Validity and reliability of the data were established through use of multiple data sources, a peer debriefer, who commented on the research process and findings, and member checks with the interview respondents to assure their words were being portrayed accurately.

Supplementary data for the study were selected from a survey and document analysis. Selected supplementary data from a survey completed by the Program for Women in Science and Engineering were analyzed. Relevant themes which emerged from the survey data were described in the analysis. In addition, selected documents from the College of Engineering and Program for Women in Science and Engineering, which were designed to promote the recruitment and retention of women in engineering, were described.

The interview and focus group data were reviewed to determine themes from the data that support or refute theoretical assumptions made by the researcher, that selected
educational environment factors affect the recruitment and retention of women in engineering majors. These themes were then discussed in relationship to related research and the previously established theoretical constructs to which they apply. Themes elicited from the primary data are listed below and discussed more extensively in the section that follows. Themes are grouped according to the constructs previously established by the researcher. They include:

Classroom Climate:

Some female students adapt to the conditions of their academic environment and differential behaviors and attitudes of faculty and peers rather than challenge them.

Discriminatory attitudes and sexist treatment of female students in engineering contribute to an unwelcoming environment for them.

Coping skills are adopted by female students to negotiate the culture in engineering major.

Faculty are viewed to have low performance expectations for female students which exacerbates concerns about diminished self-confidence, self-esteem, and intellectual ability.

A competitive classroom environment makes establishing supportive peer relationships difficult and adds more pressure for female students.

Interaction with Faculty and Peers:

Unsupportive relationships with male peers cause some female students to feel unwelcome and disparaged.

Insufficient formal and informal interaction with faculty add to an uncomfortable and unsupportive learning environment for female students.

Female faculty role models are viewed as important for some female students as an internal support system; female peer support is primary for female students.

Internal Support Systems:

Inadequate and ineffective advising and counseling are pervasive problems for female students across engineering majors.
Limited mentoring experiences cause female students to miss opportunities to establish supportive relationships with faculty which could reinforce their learning and achievement in their major.

Peer support networks provide a strong support system for female students.

Personal Fit with Major, Academic Preparation and Career Aspirations:

Students who choose engineering as a major because of intrinsic interest and drive are more likely to persist in their major, than those who select engineering primarily for material reasons or family pressure.

Preferred Teaching and Learning Styles and Methodologies:

Female students have different developmental needs and possess different teaching and learning preferences which are often neglected in male-dominated majors.

Gaps in learning and lack of voice in the classroom are experienced by some female students who feel uninformed or unprepared in engineering classes.

Classroom Climate

The responses of interview and focus group respondents to questions related to classroom climate, substantiate other research reports which indicate that women in non-traditional disciplines experience more gender related problems than do men (Hewitt & Seymour, 1991). A significant finding of this study is that women in engineering majors have experienced a range of attitudes and behaviors which have created a negative classroom climate for them. Whether real or perceived, respondents reported in their different voices frustrations engendered by biased or discriminatory treatment, a lack of attention and support by faculty and advisors, sexist jokes and comments, disparaging remarks made about women's intellectual abilities or condescending attitudes of male faculty and students toward female students.

Another major finding is that many of the respondents adapt their behavior and attitudes to fit in with the educational environment within their academic majors. This
adapted behavior, as well as concerns about recrimination and retaliation, concerns about how others might view them, and the risk that their academic goals might be jeopardized, seem to contribute to a reluctance on the part of female students to report harassing, discriminatory or differential treatment.

Most of the reports on classroom climate from interviews, focus groups and survey responses, related to sexist comments made by male faculty and students, lack of attention and support of women, being made to feel inferior, or preferential treatment of male students by faculty, rather than sexual harassment or overt discrimination. Only one survey and one focus group participant respondent reported "harassment by professors and students." However, some interview respondents reported that while they may not have been victims of harassment, they are aware that some women have been harassed by male professors and peers.

Most interview and focus group respondents were more open in discussing their perceptions and experiences related to sexist attitudes, subtle or ambiguous behaviors of faculty or peers than they were in discussing specific examples of overt discrimination, biased treatment, or harassment that they or other women had experienced. Most of the comments made by interview respondents related to discrimination and harassment were general. During a member check, one interview respondent requested that comments she had made about being harassed by a professor be omitted from the study. What emerges from the data is an apparent reluctance on the part of many respondents to report that they or women they know have experienced harassment, discrimination, or biased treatment, especially by professors.

To begin to address concerns related to classroom climate, it may prove helpful to lift the shroud of secrecy around the topics of sexism, harassment and discrimination. Perhaps, a series of anonymous, facilitated focus group discussions with interested
women across all engineering programs, might evoke sufficient qualitative data about the experiences of women to begin to identify issues and concerns and generate dialogue among faculty and administrators.

Under protection of anonymity, several interview respondents and numerous survey respondents discussed their experiences and feelings about sexist behavior or differential treatment in their academic programs. However, it is difficult to assess the nature or extent of the respondents' experiences from their survey comments. Also, self-reports do not necessarily result in full disclosure. In addition, most interview and focus group participants' comments were very generalized. Sufficient documentation of the problem is not possible because of the lack of reporting of instances of discrimination or differential treatment by female students. A "safe" environment in which to share concerns about classroom climate may generate interest in further discussion of the topic and yield information and a plan of action which could create a more welcoming environment for women in engineering and other technical fields.

According to the data from this study, women students sometimes feel that professors have lower expectations for them in classroom performance than they do for male students. This finding is premised on reports from respondents that professors tend not to call on women students in class, especially if the questions are difficult. In addition, according to some respondents, some professors direct the more difficult questions to male students and initiate contact more frequently with male students than with female students. The perception of one respondent is that professors do not call on female students in order to avoid the appearance that they are "picking on the female students". Another respondent commented that female students often sit in the front of the class to avoid being called on by the professor. Overall, active participation by female students is not encouraged in class by many professors. This observation is
important, particularly in light of research which finds that young women often enter college with a lack of self-confidence in their intellectual ability and public speaking ability (Hafner, 1989). Further, female students who already experience limited interaction in class, have the added disadvantage of a lack of encouragement and challenge from their professors.

Some respondents also expressed concerns about the competitive environment in engineering. Survey results indicated that 33.7% of respondents had experienced problems with the competitive environment in engineering. Forty-three percent of respondents indicated that they believe the competitive environment in engineering has contributed a lot to the underrepresentation of women in engineering majors. This finding is important because it illustrates the additional stress women students endure in order to persist in some engineering majors.

The pressure of "weed out" classes was described by one respondent as "unnecessarily stressful." The study indicates that women in engineering view the weed out classes as a systematic means of eliminating all but the "best and brightest" students from the program. Therefore, those female students who make it through the "weed out" classes tend to be regarded by some students as more competent than those who do not. Still, women students feel compelled to perform well above the standards of male students in order to be perceived as competent.

Some respondents reported experiencing resentful attitudes from some male students when they have received better grades than the male students. Some male students resort to downplaying the achievements of women students by attributing their success to "flirting with the teacher" or using their gender to their advantage in some way.
Hewitt and Seymour (1991) found that "the cut-throat competition" for grades in the absence of well-understood performance standards, added to lowered morale on the part of science, mathematics, and engineering majors, because grades mean survival. The focus becomes earning grades rather than learning the material. Evident in the experiences of the respondents was an unyielding concern about keeping their grades up. However, the concern had more to do with maintaining an acceptable level of performance to retain scholarships, to qualify for internships or to remain in their programs, rather than to compete against other students. It is clear that women students are keenly aware of the need to maintain certain grade point averages in order to qualify for the limited internship opportunities that exist. Internships are regarded as a necessity for getting the practical experience and making the connections one needs for getting their first job.

Some women also experienced resentment from male students who regard special scholarships, internships or career assistance for women as preferential treatment or reversed discrimination. Despite the fact that most scholarships and internships that exist in engineering programs are not targeted for females, the perception of some male students is that they are being denied an opportunity if a woman is given one.

The intense competition that exists in engineering may add to the difficulty some women students have in making connections and building supportive relationships with male peers. Systematic competition for grades runs counter to establishing positive, supportive relationships with peers.

While most respondents have developed coping skills to help them weather the stormy classroom climate they must sometimes endure, those coping skills tend not to include direct confrontation of the issues and concerns. Rather, most respondents choose to minimize the affects of the behaviors and attitudes for now, accept them as a
fact of life, or change their own behavior. For example, one respondent shared being made to feel uncomfortable when she visited a male professor during his office hours. She commented that he would always deliberately "stand too close." Rather than confront him or report the behavior, she discontinued going to his office to ask for help. In either case, subtle behaviors, as well as overt acts of bias, harassment or differential treatment tend to go unreported. Some respondents may perceive the risk of reporting the behaviors as too great. Unfortunately, many of the respondents do not feel that they have an ally within their academic programs who they can go to for support or advice. Thus, a perpetual cycle persists of inappropriate behavior or negative treatment by professors and students and "grin and bear it" attitudes by female students.

A further finding that is consistent with Hewitt and Seymour's (1991) study is that the majority of respondents who have experienced disparaging or differential treatment in their academic programs, have developed coping skills that have helped them place these frustrations aside while they remain focused on their academic goals. Most of the respondents credit their persistence with their own inner strength, intellectual abilities, hard work and tenacity. However, it is reported by some respondents that some women have transferred out of engineering majors because of the way they were treated by male faculty and peers.

Interaction with Faculty and Peers

An important finding in the study is that women in engineering have difficulty establishing supportive relationships with faculty. Opportunities for sustained, positive formal and informal interaction between women students and faculty are minimal, according to many respondents. A resounding comment from most interview and focus group respondents was that "faculty" do not care about students. Rarely were references
made about specific faculty, but about faculty in general. One explanation that the data suggests is that there is a correlation between the perception of lack of care and concern by faculty and the atmosphere in large lecture classes where it is nearly impossible for faculty to interact in meaningful ways with students. Studies indicate that it is important for women students to be able to establish relationships with faculty so that faculty know who they are and are more aware of their needs and concerns (Hewitt & Seymour, 1991). Hewitt and Seymour (1991) found that women have a more affective orientation toward education which necessitates getting to know the professor and other students in their classes in order to feel comfortable and welcomed. When respondents said they believed professors didn't care, most responses were in relationship to large lecture classes where faculty were not able to interact with students. Also, the fact that the respondents had no other opportunity outside of class to get to know their professors, distanced them even further from them. This observation suggests that in the absence of opportunities to interact with students in large classes, faculty should seek other ways to establish informal contact with women students. Some respondents indicated a need for faculty they could feel comfortable going to when they had questions, problems or concerns with classes, grades, or what courses to take. For other respondents, having faculty show signs of friendliness was important. For many respondents the faculty member did not necessarily need to be a current professor.

A related finding is that the perception of women engineers was that the level of interaction between faculty and students varies by department or major. In general, large majors with few women students were perceived to have the least interaction with students and women seem to have more problems developing relationships with faculty and peers. In contrast, majors with small total numbers of students or those with significant numbers of females, were perceived to be more open and easier for women
to establish relationships with faculty and peers. Those interview respondents and focus group participants in majors with small total numbers of students or significant numbers of female students, reported fewer problems in establishing relationships with faculty and male peers and greater overall satisfaction with their programs. This finding implies that smaller, more intimate class settings provide a level of comfort and support for women students that is not possible in large lecture classes. Therefore, first and second year women in engineering may experience more problems while taking introductory classes and need more support. Also, this finding suggests that a critical mass of female students in a major, may sufficiently alter the student composition to create a more open and welcoming classroom environment. Lantz (1982) suggests that in order to recruit and retain members of a population on a sustained basis, a critical mass of at least 15% to 20% of those members is needed.

One respondent who had been invited to "faculty nights" at the homes of faculty members felt that this was the best experience she had for establishing relationships with faculty. Most respondents felt that they had no opportunity to get to know faculty in or outside of class. Few respondents felt comfortable going to their professors' office hours for help with class problems because of the perception that faculty did not want to be bothered with students. Many female students also do not view it in their best interest to regularly visit the office of a male professor, especially without a "legitimate reason" (class related business), because of the perception it might create that she is using her gender to solicit good grades. In essence, unless faculty create opportunities in neutral settings to interact informally with female students, they will be precluded from developing relationships which female students regard as important in their educational experience.
Findings from this study related to female faculty, raised an interesting dichotomy. Most interview respondents indicated that they could not of perceive ways in which the classroom environment would change if more female faculty were hired. There did not seem to be an assumption that female faculty would automatically bring a more acceptable set of attitudes or behaviors to the classroom which would result in a more positive environment. Based on the comments of interview respondents, female faculty who do not fit masculine models of leadership, are not viewed as positive role models. For example, female faculty in engineering who present themselves as timid, unassertive and weak, rather than forceful and strong are viewed negatively by some women students. There also seemed to be a sense of disappointment on the part of some respondents that the female faculty they have had do not meet their standards of "an engineer." That standard appears to be the traditional male standard, (strong, forceful, confident) which, ironically, many respondents indicate is too impersonal, uncaring and exclusive. Perhaps respondents who say they do not feel a need for more female faculty, are really saying they do not feel a need for certain kinds of female faculty.

The data from interview respondents supports Hewitt and Seymour's (1991) findings that women students tend to evaluate male professors based on their interpersonal characteristics, rather than their teaching abilities and methods. The data also suggest that female faculty are evaluated by some women more critically than male faculty, based on their personal traits, rather than their knowledge of the subject matter or teaching abilities.

Several focus group participants expressed that more female faculty role models are needed and more opportunities to interact with other women would be beneficial to them as a support system. One survey respondent commented that she felt more female faculty are needed in engineering. (No survey question specifically asked respondents if
they felt more female faculty should be hired, so this response may not be representative of the views of all respondents on this topic).

Respondents from interviews, focus groups, and surveys expressed a clear need for more female peers in their majors. This need seems to outweigh the need for more female faculty for many respondents. This finding suggests that female students need greater support at the peer level first. In the absence of strong male peer relationships, the need for female peer relationships is heightened.

A finding that is troublesome is that negative attitudes and sexist treatment by male peers emerged as a pervasive problem in the classroom environment for many interview respondents and focus group participants. Sexist comments which diminish women's intellectual abilities or otherwise regard them as inferior, or comments which perpetuate stereotypical images of women, were reported as commonplace. Comments which suggest that women who do well academically succeed because "they are cute or they flirt with the teacher," or that "girls" don't really need to understand engineering because they aren't serious about it anyway, underminewomen's self-confidence and devalue their goals and aspirations.

This finding is especially important for educators interested in creating a classroom climate that is conducive to the success of young women from the time they first enter engineering or other technical fields. According to Hafner (1989) first year females enter college with lower self-confidence than males regarding their academic abilities, math ability, and public speaking ability. In addition during college, women's self-esteem declines. Disparaging attitudes and behaviors from peers may further compound the problems some young women face and negatively affect their ability to persist in the major.
Some women decide to alter their behavior in the classroom in order to co-exist with male students. In reports from focus group participants, some women will choose not to sit next to a male student in class or speak to him first, for fear their "forwardness" will be perceived as a sexual advance. As a result, some women do not establish relationships with male peers that could provide support to them. Other women view such attitudes and behaviors as a part of the culture of their program which they must learn to endure or accept.

Most respondents expressed the need for more female students in their major areas. The need for female peers for support and encouragement was voiced consistently by interview respondents and focus group participants. Although several interview respondents indicated that they are not bothered by the fact that they are the only female or one a few females in their classes, they also indicate in other comments that female peers are an important support system.

Internal Support Systems

Findings from the study related to internal support, indicate that most respondents were concerned about "poor advising" and difficulty working with and understanding foreign teaching assistants. Respondents' concerns did not necessarily relate to gender differences, since they indicated that male students express these same concerns.

Concerns about inadequate or ineffective advising and foreign teaching assistants were shared by interview respondents, focus group participants and survey respondents. The basis for the respondents' concerns about academic advising centered on the lack of interest some advisors show in wanting to help students and advisors giving inaccurate information to students. Respondents indicated that they avoid going
to their advisors and try to find a faculty member to advise them on what courses to take. They only go to their advisors to get signatures when necessary.

Concerns about teaching assistants related to language differences and misunderstandings that result from them. Respondents indicated that they feel their teaching assistants try to be helpful, but they become frustrated trying to ask questions in ways that their teaching assistants hear the questions they are asking.

A finding of the data is that respondents do not feel that they can impact the advising system in their majors. Respondents who indicated that they have attempted to share their concerns and to get help from their departments felt that the advisors were defended and their concerns were dismissed.

None of the respondents indicated that they are participating in arranged or structured mentoring experiences with faculty. One respondent indicated that she has a "mentoring type" relationship with a faculty member for whom she works. The data indicate that it is difficult for women students to find mentoring opportunities. It appears that in the absence of a mentoring program which assures women are consistently matched with faculty, women who want such experiences must take the initiative to find interested faculty and establish their own program. Given the difficulty women students already have establishing supportive relationships with their professors, it is easy to see why mentoring opportunities are elusive for them. If women students were able to develop supportive relationships with individual faculty on a consistent basis, mentoring experiences might be less critical. However, since informal interaction with faculty is often missing for many women students, the necessity for formal interaction, such as mentoring, becomes more crucial. Engineering programs which do not hear from women students about their feelings of lack of support, lack of positive
interaction with faculty and limited mentoring opportunities, should not assume that their needs and interests are being met within the existing program structure.

An important finding that emerged from the study is the need for stable peer networks for women students. Establishment of peer networks in the major was regarded as an important support system by many respondents. Peer networks could provide social relationships with other students, study or help groups, and more meaningful interaction with classmates.

Several focus group participants also commented that during their first year in their major they struggled because of the lack of a basic orientation to the major. What would have been helpful was to be paired with an upperclass peer (preferably female), who could orient them to the campus, the academic program (the nature of introductory classes, attitudes of professors, etc.), basic computer and equipment operations they would need for classes, and "be a friend." Being alone the first year at college, during a time of major life transitions, was expressed as a major concern by a number of interview and focus group participants.

**Personal Fit with Major, Academic Preparation and Career Aspirations**

A finding related to academic preparation indicates that most interview respondents feel successful in their academic programs, despite concerns about the classroom climate, lack of faculty interaction and support, or limited internal support. After initial confusion and disbelief, most respondents have resolved that they will not necessarily achieve the A's and B's they earned in high school, that they are not necessarily going to be the top students in their classes, and that their professors are not going to push them to be successful, or single them out for attention and promotion. This was a radical departure for some respondents who experienced the opposite
outcomes in high school. The data suggest that most of the respondents have sufficient intrinsic interest in engineering to be self-motivated and to put forth the effort necessary to meet the challenges they face in completion of their academic programs. This finding supports the researcher's contention that these respondents have developed individual coping skills (denial, acceptance, or adjustment) that have made it possible for them to maintain focus on their academic goals.

Preferred Teaching and Learning Styles and Methodologies

Another concern indicated by this study is that female students exhibit gaps in their learning and a lack of voice in the classroom. Most of the interview respondents and focus group participants shared that they often feel uninformed or unprepared in class. This phenomenon is evidenced by women's lack of comfort and lack of interaction in the classroom. Most respondents indicated that they do not, nor do many other women ask questions in class or comment during the lecture. They attribute this reluctance to the fact that male students appear to possess greater knowledge and practical experience with scientific or technological concepts. Therefore, male students are assumed to know more and are rewarded by the professors (e.g., good grades, more interaction during class with the professor). Most respondents also feel that most professors make the assumption that male and female students have the same knowledge and experience base. For example, many respondents commented that when the class session deals with engines, professors receive affirmation from male students that they understand the lecture and they move on to other concepts. Some students (male and female) are left perplexed, but rarely will students ask questions or ask the professor to clarify the lecture.
The respondents' experiences are consistent with findings of a study conducted by Belenky et al (1986), which suggest that women in educational settings often feel that there are gaps in their learning that make it difficult for them to be successful. Women's learning experiences have often not focused on the same educational precepts and priorities that male students have been taught. Gilligan (1986) suggests that women's orientation has focused on developing an ethic of caring and taking responsibility for others. During their school years, young girls are nurtured, paid attention to and those with special aptitude for math and science are encouraged by teachers and parents to enter non-traditional fields (Hewitt & Seymour, 1991). When women enter higher education, they find that the culture is unfamiliar to them. This is particularly true in male-dominated fields, such as engineering. Such disciplines are based on a male-dominated agenda and perspective, which does not provide the affective orientation many young women have been socialized to expect from their teachers (Belenky et al. (1990). As a result the culture of higher education and its concomitant demands and expectations are unfamiliar and uncomfortable for some women.

An additional finding of the Belenky et al (1986) study is that women have more difficulty than men in expressing themselves as authorities. Women are taught as children to defer to the judgement and opinions of others, rather than to promote their own ideas (Gilligan, 1986). As a result, asking questions in class or giving one's opinion is often perceived as a significant risk by some women. They may already feel they lack a sufficient knowledge base in the class and that they are not viewed by their peers as intellectually competent to begin with. Several respondents expressed feelings of being "made to feel dumb"by professors and peers. One interview respondent commented that she feels vulnerable asking questions of her professors because she
"may get shot down and made to feel stupid." Whether these feelings are the result of actual experiences or merely perceptions of students, the reality is that the ability of some women to actively participate in class and feel comfortable about their experiences, is being further impaired by faculty's lack of awareness of the different developmental needs of women students. Further, because the culture of engineering is so entrenched, (as are all disciplines) most women accept the standards within their majors as the rule and do not feel that they have the right to question things or expect them to be different. Even more basic to this thesis is that women do not tend to think about whether the culture within their major, the teaching methods of faculty or expectations of them are right or not, instead they try to find ways to adjust themselves to fit within the major. As one respondent said, "women never think about how they feel in classes."

A major finding related to teaching and learning preferences of women students is that they prefer learning that begins with personal experiences and relationships. This finding is consistent with research conducted by Belenky et al. (1986), which found that the most powerful learning experiences reported by women in educational settings were based on personal experiences. While comfortable with learning and handling abstract concepts, women in Belenky's et al. (1991) study found that women use abstract concepts to make sense of their personal experiences, but have difficulty finding them useful if they precede their personal experiences. This may account for the overwhelming responses from interview and focus group participants that they learn best from seeing examples or practical applications. This approach gives women a way of connecting abstract concepts with their personal experiences and then helping them relate those personal experiences to other situations.
A recurrent view of many respondents is that large lecture classes are not helpful to them in the learning process. The data indicate that this is partly attributable to the lack of interaction between students and faculty. For women students lack of interaction with faculty and peers leaves a void in their educational experience and makes it more difficult for them to feel connected in their learning. What most respondents indicate is that small, interactive classes or labs where faculty and students can know each other on a more personal basis, are most helpful for them. This finding establishes more clearly the importance of positive relationships with faculty and peers in the educational experiences of women.

Most respondents do not feel that it would make a difference if they indicated to their professors that their teaching practices or methods were ineffective for them. One respondent indicated that such initiative on the part of students would probably be "risky."

Recommendations

In examining the findings of this study, the following recommendations seem useful for further research and practice. They are that further qualitative and quantitative research be conducted on:

1. the quality and satisfaction of the educational experiences of undergraduate women in engineering.
2. factors which cause women to make a decision to transfer from engineering majors or to persist in them.
3. the perceptions and experiences of ethnic minority women in engineering and factors that affect their retention in their academic disciplines.
4. perceptions and experiences of male students about their undergraduate educational experiences compared to those of female students, and,
5. the affects of incorporating tenets of female developmental theory into classroom instruction in male-dominated classes.

This study described and analyzed the perceptions and experiences of selected undergraduate women in engineering. Some data were generated relevant to the quality of the educational experience and satisfaction of the respondents with their academic programs. However, because of the lack of focus on this question, the study did not produce a comprehensive assessment of quality of experience or satisfaction of the respondents’ with their academic programs. A quantitative study related to satisfaction of women in engineering could provide more representative data from which transferable data could be drawn to a broader population. This approach could better demonstrate the breadth of attitudes, perceptions and experiences of women in engineering fields.

This qualitative study focused on providing depth of understanding of the unique experiences and perceptions of selected women in engineering. However, it did not include a study of women in engineering who have transferred to other majors. Because the respondents in this study were all persisters at the time of the study, it is inconclusive what specific academic program related concerns or other factors cause some women to transfer out of engineering programs at Iowa State University. A study of transfer students might reveal significant data that were not revealed in this study. For example, a comparative study of persisters and transfers, including male and female subjects, could provide a significant data base for greater understanding of retention issues related to all students. This study does provide some insight into what has contributed to the respondents’ persistence in engineering.

The study did not focus on the perceptions and experiences of ethnic minority women, leaving a void in the research in this area. The respondents who participated in
this study were white American women and Asian American. No African American women participated in the study. Some research data suggest that the experiences of African American women in technical fields such as engineering, are exacerbated because of racial and gender differences (Hewitt & Seymour, 1991), so their accounts of their experiences may be very different from those of white American women.

Since the respondents used in this study are all females, comparisons cannot be made between perceptions and experiences of male and female students. Evaluating only the experiences of women in a predominantly male discipline may not take into account the special dynamics that interact and affect both men and women (e.g., competition). Problems related to classroom climate, internal support and faculty interaction, for example, may indeed negatively affect male students in engineering as well as female students. Program enhancement and improvements in educational environments and support systems may be aided significantly by comparative studies of both groups.

Classroom instruction in higher education typically follows traditional instructional methods and pedagogical practices (e.g. lecture method) (Saigel & Saigel, 1988). Classes in technical fields such as engineering are no exception. When traditional methodologies are adhered to in male-dominated disciplines, the combination precludes the inclusion of instructional methods based on some female students' learning needs and style preferences (The same may be true of some male students). Some developmental theories related to women indicate that woman have different learning needs and style preferences than men (Gilligan, 1982). Research that examines the learning needs and preferences of women in the context of male-dominated disciplines, is needed to help faculty and administrators better understand the differing needs of women in engineering fields and respond more appropriately to those differing needs.
Finally, some practical recommendations are useful beyond further research on theoretical development in the area of learning needs and preferences of female students in male-dominated disciplines. For example, the development of a structured peer support network throughout the undergraduate experience would be helpful to many female students. Female upperclass engineering students could be paired with freshmen and sophomores to provide orientation and support during their transition to their major and Iowa State University. In addition, the development of a structured mentoring program for female engineers and faculty could assist those who are not able to establish supportive relationships with faculty on their own. Rewards for effective mentoring partnerships could be provided to both faculty and students to encourage more active, long term participation (e.g. consideration in promotion and salary decisions, faculty/student luncheons and group discussion series).

Conclusions

Women who choose to major in engineering or other male dominated disciplines assume additional challenges apart from the curriculum demands of their majors. They must negotiate an educational culture which they have had no part in creating. Their educational needs and interests are assumed to fit within the existing culture. As a result, there is no real systematic recognition of the need for changes in the way female students are viewed and educated by institutions of higher learning. The differing developmental or educational needs women bring with them to the classroom are often neglected. Further, there are no incentives for faculty to consider how they might adjust their pedagogical practices or the way they relate to students in order to better meet the needs of female, and perhaps male students. Therefore, it is the researcher's contention that key departmental administrators and faculty in engineering programs should
become actively involved in a review and analysis of the educational needs of female and male students in their departments. As a starting point for improving awareness, faculty and administrators could perhaps benefit from seminars that present experiential data related to the perceptions and experiences of women in their academic programs. In addition, anonymous focus group discussions could be held with a cross section of female and male students in which they could consider how they are affected by academic environment issues. This approach could reveal useful insights and provide new directions for change that could benefit all students.

In order to promote a more open and accepting environment for women in male-dominated professions, we must address the problems they face in the academic environments within which they are trained. The mere presence of female students in engineering and other male-dominated fields does not translate into an automatic change in attitudes and behaviors about women and their expected roles in society. Nor can female students be expected to be the primary change agents within their academic programs. For, not only must female students be able to compete successfully with male students for acceptable grades in a challenging field, they must also find ways within themselves to negotiate an academic culture that has been designed by and for men.

While increasing numbers of women are enrolling in engineering disciplines, many of those who persist appear to experience attitudes and behaviors which discourage their presence and minimize their achievements. Yet, despite the environmental obstacles they face, many women continue to draw upon their inner resources to survive. Many continue to maintain strong academic standings. Their intrinsic interest in engineering and personal commitment and drive, encourage them to work around these obstacles and remain focused on their academic goals. Many of
those who persist pay a personal price for doing so, but as indicated by the data, feel that it will be worth it to receive a degree in engineering. What remains to be examined is what personal costs women are paying to receive their degrees in engineering.
BIBLIOGRAPHY


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Iowa State University (n.d.) Works for Women in Engineering (Program for Women in Science and Engineering Brochure)


Research in Higher Education. 9, 137-152.


"Follow your dream...if you stumble, don't stop and lose sight of your goal. Press on to the top. For only on the top can you see the whole view." Amanda Bradley

My deepest love and appreciation are extended to my parents, William and Ophelia, for your unyielding love, prayers, nurturance, encouragement and support. You have helped to shape who and what I have become and have always believed in me.

To my husband, Dennis, I am grateful for your constant love, encouragement and support. There were times we had to push each other up the rough side of the mountain, but going through this journey together has made getting to the top easier.

To my brothers and sisters, Larry, Ethel, Gloria, Joe, Charles, Evelyn, Jimmy, Ricky, Denise and Anthony. I am grateful for your love, support and faith in me through the years. Thank you for always being there for me when I have needed you.

To Mary Foust, my dearest sister/friend. Your love, friendship, and support through the years have been solid rocks for me.

I will always appreciate the love, encouragement, and support of my mother-in-law, Georgia Mae Haggray, and my brothers and sisters, Sheryle, Barbara, Jeffrey, Vernard, Chris and Toni Haggray. You are very special to me.

I wish to extend my special appreciation to my major professor, Dr. Daniel C. Robinson, for your direction, support and encouragement. Thank you for guiding "my little walk" on this journey. I would also like to express my sincere appreciation to my doctoral committee for their constructive support and guidance, Dr. Richard Warren, Professor, Research and Evaluation in the Department of Professional Studies, Dr. Larry Ebbers, Professor in the Department of Professional Studies, Dr. Ann Thompson, Chair of the Department of Curriculum and Instruction, and Dr. Martin Miller, Professor in the
Department of Sociology and Social Welfare. I have benefited immensely from our association.

I wish to extend special thanks to Chuck Frederiksen, Gary Schwartz, Virginia Arthur, and all of my colleagues in the Department of Residence for your constant encouragement and support.

To the many friends and colleagues who have supported and encouraged me throughout this four and a half year journey, I extend a special thanks. Carlie and Gary Tartakov, Cortez Henderson and Harvey, George and Clemie Jackson, Jerry and Beverly Peoples, Michael Sutton, Beverlyn Johnson, Rev. & Mrs. Jimmy Mumford, Marlena and Bobby Beavers, Jackie Mitchell and others too numerous to mention.

My sincere appreciation goes to Mary Ann Evans and her staff in the office of the Program for Women in Science and Engineering for their assistance in collecting data for this study.

Finally, I wish to extend my special thanks to my friend and technical consultant, Jill Shannon, for coming to my rescue when called upon and helping me to put the finishing touches on this dissertation.
APPENDIX A. LETTER TO RESEARCH PARTICIPANTS
April 11, 1992

Dear: ________________________:

We are currently conducting a study of the educational experiences and perceptions of undergraduate women in engineering majors at Iowa State University. The study will be qualitative in nature, which means that the data will be collected primarily through interviews with the research participants. The data collected from this study will be used for a dissertation.

We are requesting your participation in this study. This study will provide a unique opportunity for you to share your experiences and perceptions as a woman in engineering at Iowa State University. The study could create greater awareness and understanding of the unique needs, issues, and concerns of women in engineering.

Please be advised that your participation in this study is voluntary. In addition, all information collected from you and your identity will be kept confidential. You will have an opportunity to review the transcript of your interview to confirm the accuracy of your statements and discuss the researcher's interpretations.

So that I can confirm your interest in participating in this study, please complete and return the attached form in the enclosed envelope by Thursday, April 16, 1992. Please mail the completed form to:

Annette Haggray
Union Drive Complex Office
2419 Friley Hall

If you indicate an interest in participating in the study, I will contact you by telephone to arrange our first meeting and to clarify the goals and process for the research study.

Your time commitment for the study will include a two hour individual interview session, review of your transcript and follow-up with the researcher to negotiate any changes.

If you should have questions, please call me at 294-1300 during the day or at 292-0398 during evening hours.

We greatly appreciate your consideration of our request to participate in the study and will look forward to hearing from you.

Sincerely,

Annette Haggray
Ph.D. Candidate
Iowa State University

Dr. Daniel C. Robinson
Major Professor
Section Leader, Higher Education
APPENDIX B. LETTER TO FOCUS GROUP PARTICIPANTS
March 19, 1992

Thank you for volunteering to participate in a group discussion regarding the Program for Women in Science and Engineering at Iowa State University. We look forward to seeing on Thursday, March 26, at 7 p.m. in Room 232, Carver Hall.

Sincerely,

Mary Ann Evans
Sally Hinders
Holly Kanengieter
Program for Women in Science and Engineering
210 Marston Hall
(515) 294-9964
APPENDIX C. CONSENT FORM (FOCUS GROUPS)
RESPONDENT CONSENT FORM

Purpose of the Interview

The purpose of this interview is to better understand the educational experiences of women in science and engineering at Iowa State University. In gaining knowledge of the institutional conditions that affect women students, PWSE can work to develop an environment more conducive to their educational needs. Comparable institutions, especially other land-grant institutions may also benefit from this study. By interviews, reviewing printed materials and observation of the environment, we plan to obtain information needed to write a report on our findings in relation to the above stated goals.

We want to talk with you for about an hour concerning topics related to your experience at ISU. After reviewing the information obtained during the discussion, you may be contacted again to seek clarification about the information.

I understand that:

(a) The information obtained during this project will be summarized for the purpose of writing a report on our research.

(b) The recordings and notes obtained in this interview will not be reviewed by anyone other than the research team.

(c) My name or any identifiable information will not be used in a written or oral report of the research findings.

(d) My participation in this project is voluntary. I may withdraw at any time by speaking to the investigator and any information collected from me will not be used in the study.

I agree to participate in this research project according to the preceding terms.

Signature: ____________________________
(address)

Telephone: ____________________________

I agree to conduct this research according to the preceding terms.

Signature: ____________________________
(date)
APPENDIX D. CONSENT FORM (INDIVIDUAL INTERVIEWS)
RESPONDENT CONSENT FORM

PURPOSE OF THE INTERVIEW:

The purpose of this interview is to collect information which will enhance our understanding of the educational experiences of women in engineering majors at Iowa State University. In creating greater awareness and understanding about the actual experiences, observations, and perceptions of undergraduate women in engineering, unique issues or concerns may be identified and addressed which may lead to increased persistence of women in engineering fields.

I, ____________________________, agree to participate in this study and understand that:

(please print)

a. the information obtained during this study will be used anonymously in a dissertation which will be read by the researcher and faculty members who serve on the researcher's dissertation committee.

b. real names will not be used during data collection or in the final dissertation draft. My confidentiality will be maintained throughout the study.

c. the interview sessions will be audio-taped. The tapes and all notes will remain with the researcher. Only the researcher and research participant will read individual raw data (transcripts).

d. I may review the transcripts from my interview to verify the collected data. I also have the option to negotiate changes in statements I have made and interpretations of my words by the researcher.

e. my participation in this study is voluntary. I may withdraw from the study at any time by informing the researcher. At my request, information collected from me will not be used and I may refuse to answer any questions asked by the researcher.

f. I understand that participation in the study involves a two hour session of individual interviews, reading my transcript and follow-up with the researcher afterwards.

g. I understand that I will not receive any remuneration for participating in this study.

I agree to participate in this research project according to the preceding terms.

_________________________________________  ________________________________
(Respondent's Signature)                   (Address)

_________________________________________  ________________________________
(Date)                                      (Telephone Number)

M.A. Haggray, ISU (8/92)
APPENDIX E. INDIVIDUAL INTERVIEW QUESTIONS
INDIVIDUAL INTERVIEW QUESTIONS

The following interview questions were asked of each respondent.

1. Would you share some biographical information about yourself (where did you grow up; parents' education/career background; early schooling, etc.)?

2. How did you come to be where you are today? What/who influenced your choices?

3. Why did you choose to study engineering?

4. What are your short term (3-5 years) and long term career goals (5 years and beyond)?

5. What did you expect from your experiences as a student in engineering when you first arrived at Iowa State University? Have your expectations been met? Please explain.

6. How is/has your academic training in engineering at Iowa State University preparing/prepared you to enter your chosen profession?

7. What types of learning experiences have you had in your academic program which you feel were the most helpful? Least helpful?

8. How would you describe your relationships with your professors? Peers?

9. What have been sources of encouragement for you in your academic program? What have been sources of discouragement for you in your academic program? In what ways have you been encouraged/discouraged? Give examples related to male and female faculty, staff, peers and mentors and types of support.

10. How would you describe a typical class period in your major? What goes on? Who participates and talks? Who does not participate or talk? How do people participate and talk? Why do you think the class is the way it is?

11. How does it feel to be in a typical engineering or science class?

12. How are female and male students respectively, treated by male professors? Female and male students? Is there a difference in the way female students are treated compared to male students? If so, how is it different?

13. What is the most effective teaching and learning strategy for you, i.e. how do you learn best? How have you come to know this?

14. How would you describe the teaching styles of your professors? In what ways are they conducive (or not) to your particular learning style and needs/ the learning styles and needs of other women? Please explain.
15. Do you feel that your professors are (1) aware of your learning needs and style? Do you feel that your professors make an effort to vary their approach or style to meet your needs or the needs of other women students?

16. What opportunities are you aware of that are available for women students for internships, leadership positions in engineering associations, or employment? How did you (does one) learn of these opportunities? How do these opportunities compare to those male students have primarily benefited from?

17. What do you like/dislike the most about your academic program? How is it different from or similar to what you expected?

18. Do you feel that you have been successful in your academic program? In what ways?

19. What factors do you feel have been most instrumental in your achievement and success in your academic program? What have been your support systems?

20. What would be helpful to you at this point in your academic program?

21. What did you think about pursuing engineering as a career before you became a student in engineering? Have your views changed? If so, please explain.

22. How would you compare your experiences in your academic program with those of other women students? Do you think that the experiences you have had in your academic program have been vastly different from those of other women? Please explain.

23. Do you think that the experiences of women in your academic major vary according to their classifications (freshman, sophomore, junior, senior)? If so, how?

24. If you could change your experiences as a student in the engineering program at Iowa State University, how would you change them? What wouldn't you change?

25. What advice or suggestions would you give other women students who are considering pursuing an engineering major?

26. If you had it to do over again, would you complete the same academic program? Why or why not?

27. Do you feel that your academic program is doing enough to encourage the recruitment and retention of women students? What suggestions can you offer?

28. Is there an area that we have not discussed or a question I have not asked which you would like to respond to?
APPENDIX F. FOCUS GROUP QUESTIONS
FOCUS GROUP QUESTIONS

1. Why did you choose your field of study?
2. What did you expect it would be like being a student in the first year of your program of study at ISU?
3. Where your expectations different from your actual experiences?
4. Since you have been enrolled at ISU, how would you describe your relationships with faculty? With peers?
5. How would you describe the way female students are treated in your program?
6. How would you describe the way male students are treated in your program?
7. What have been sources of encouragement for you in your program?
8. What have been sources of discouragement for you in your program?
APPENDIX G. SURVEY
UNDERGRADUATE QUESTIONNAIRE FOR WOMEN IN SCIENCE AND ENGINEERING

The Program for Women in Science and Engineering (PWSE) is interested in learning about you, the women students, and how Iowa State University meets your needs. Please answer each of the questions by circling the appropriate response or filling in the blank. Thank you for your help.

I. YOU AND ISU

1. What is your college?
   1. Agriculture
   2. Engineering
   3. Family & Consumer Sciences
   4. Liberal Arts & Sciences
   5. Other

2. Do you have another degree(s)?
   1. Associate Degree
   2. Bachelor of Arts
   3. Bachelor of Science
   4. Masters

3. What is your academic major? __________________________ (No Abbreviations Please)

4. Are you enrolled as a?
   1. Full-time student
   2. Part-time student

5. Are you currently a?
   1. Freshman
   2. Sophomore
   3. Junior
   4. Senior

6. Including this semester, how many semesters have you attended ISU? ______

7. What is your current G.P.A. (on a 4 point scale)? ____ . ____ __
8. Why did you choose to attend ISU? Please circle all reasons you had for coming to ISU.

01. Location
02. Faculty member
03. Facilities (e.g., lab . . .)
04. Cost
05. Housing
06. Spouse/partner
07. Restricted mobility
08. Availability of childcare
09. Financial aid package
10. Family member attended ISU (Please specify relationship of family member.)
11. Quality of campus life
12. Reputation of departmental program
13. Reputation of ISU
14. Availability of desired major or program
15. Community environment
16. Opportunity to participate in student organizations
17. Other, please specify: ____________________________ ____________________________

9. Had you decided on a major/minor when you applied to ISU?

1. Yes
2. No

10. Have you changed your major since entering ISU?

1. Yes, If so please specify
   Previous Major: ______________________________________
   Why You Changed? ______________________________________

2. No

11. While at Iowa State University, have you had any uncomfortable experiences in your academic program?

1. Yes, please specify: ______________________________________

2. No
II. WOMEN AND SCIENCE

12. When did you first become interested in your field of study? Please circle the most appropriate response.
   1. In Childhood
   2. In Junior High
   3. In High School
   4. While in College
   5. While working full-time after high school or college
   6. Other, please explain: __________________________

13. Which of the following people encouraged you in your major. Please circle yes or no for each of the following.

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family members</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Teacher or counselor</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Professional in desired major or field of study</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Other adult</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Friend or fellow student</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Other, please specify:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

14. Did you choose your field of study for any of the following reasons? Circle yes or no for each.

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>High school course(s)</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Work experiences</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Good pay</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Prestige of major or field</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Availability of jobs</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Its importance for preparation for intended career</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Strong background in major or field</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>My talent in my major or field</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Personal enjoyment or interest in major or field</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Other, please specify:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
15. Who or what provided you with information about this field or careers in this field? Circle all responses that apply.

01. High school teacher
02. High school counselor
03. Professional in field
04. Friends/fellow students
05. Work experiences
06. College courses
07. High school courses
08. Family member
09. College faculty or staff member
10. Summer internship in your major or field
11. Career conferences (i.e., ISU, high school, other...)
12. Role model outreach program (guest speaker/lecturer, workshops)
13. Media
14. Other, please specify: ________________________________

16. In the past, fewer women than men have pursued careers in science, math, or engineering. The reasons listed below have been suggested as factors contributing to the low numbers of women in these fields. Based on your observations and experiences, how much do you think these factors contribute to the underrepresentation of women in science, engineering, and other technical fields today?

In column A, please indicate the degree to which you believe each factor listed below has contributed to the underrepresentation of women in these fields by circling the appropriate response.

In column B, please indicate whether these factors have been a problem for you by circling the appropriate response.

<table>
<thead>
<tr>
<th>Factor</th>
<th>A</th>
<th>B</th>
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<tbody>
<tr>
<td>Long years of formal preparation</td>
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<td></td>
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<tr>
<td>Possible conflicts between career and family</td>
<td></td>
<td></td>
</tr>
<tr>
<td>View that women in the technical fields are unfeminine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of encouragement from teachers or counselors in high school</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of encouragement from college faculty and advisors</td>
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<td></td>
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<tr>
<td>Lack of encouragement from family and friends</td>
<td></td>
<td></td>
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<tr>
<td>Women's lack of confidence that they can handle the work</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of information about careers in scientific field</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>None</th>
<th>Some</th>
<th>A Lot</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long years of formal preparation</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Possible conflicts between career and family</td>
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<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
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<tr>
<td>View that women in the technical fields are unfeminine</td>
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<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Lack of encouragement from teachers or counselors in high school</td>
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<td>2</td>
<td>3</td>
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<td>3</td>
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<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
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<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Lack of information about careers in scientific field</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>
III. PROGRAM FOR WOMEN IN SCIENCE AND ENGINEERING (PWSE)

17. (a) Did you participate in any PWSE (Program for Women and Science and Engineering) sponsored events during high school? (i.e., career conferences, summer internships...)

1. Yes
2. No (Go to Q18)

(b) If yes, please indicate which event(s) by circling those you were involved with.

1. Summer Internship
2. Career conference
3. Role model program
4. Other, please specify: ________________________________

18. Upon entering ISU, did you know about PWSE?

1. Yes
2. No

19. Have you had any contact with PWSE since attending ISU?

1. Yes
2. No
20. Women in Science programs at other institutions sponsor many different kinds of activities for undergraduate students. We have listed some of them below. Some of these programs are offered by departments at ISU. PWSE would like to implement more activities for women students.

In column A, circle all activities you have participated in.

In column B, circle all you would be interested in participating in.

<table>
<thead>
<tr>
<th>A Activities you have participated in</th>
<th>B Would you participate in these?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Nb</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td>a. An orientation program for women in technical studies</td>
<td>1</td>
</tr>
<tr>
<td>b. Peer study groups</td>
<td>1</td>
</tr>
<tr>
<td>c. Career options sessions</td>
<td>1</td>
</tr>
<tr>
<td>d. Research and internship opportunities</td>
<td>1</td>
</tr>
<tr>
<td>e. Brown bag lunches with others from your department</td>
<td>1</td>
</tr>
<tr>
<td>f. Planned informal discussions with faculty</td>
<td>1</td>
</tr>
<tr>
<td>g. Social events (ie. aerobics, pizza parties...)</td>
<td>1</td>
</tr>
<tr>
<td>h. Informal student seminars</td>
<td>1</td>
</tr>
<tr>
<td>j. Opportunity to be affiliated with chapter of state/ regional/national professional organizations</td>
<td>1</td>
</tr>
<tr>
<td>k. Formal workshops on topics such as, selecting a graduate school, applying for research grants, graduate assistantships, scholarships, fellowships</td>
<td>1</td>
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</tbody>
</table>

21. We are trying to determine the best times in which to offer new programs. Please indicate by circling which time works best for you. (Please circle top two choices.)

1. Afternoons
2. Lunch Hour
3. Evenings
4. Weekends
5. Morning
IV. DEMOGRAPHICS

22. What is your current age? 

23. What is your current marital status?
   1. Single-never married
   2. Married/living as married
   3. Separated/divorced
   4. Widowed

24. (a) Do you have any children living with you?
   1. Yes
   2. No (Go to Question 25)

   (b) How many live with you? 

   (c) How many are:
   1. Preschool Age?
   2. Elementary Age?
   3. Junior High age?
   4. High School or older?

25. Are you a United States Citizen?
   1. Yes
   2. No (Home country Go to Question 27)

26. Are you resident of the state of Iowa?
   1. Yes
   2. No (Permanent state of Residency )

27. What is your ethnic origin?
   1. Native American
   2. African American
   3. White (Not Hispanic)
   4. Hispanic (Spanish American)
   5. Asian American or Pacific Islander
   6. Other
28. (a) Are you currently employed?
   1. Yes
   2. No (Go to Question 29)

(b) Are you employed:
   1. Off-campus
   2. On-campus
   3. Both

(c) This semester, in a typical week, how many hours are you employed?_____

29. Do you live:
   1. Off-campus
   2. On-campus

Would you participate in the opportunity to meet with a small group of other women in science and engineering programs to confidentially discuss your experience at ISU? If so, please list an address, day and evening telephone number where we can reach you, as well as your class/work schedule, and we will follow up with you to arrange a convenient time. Your participation will be most appreciated!

Name:

Present local address:

Telephone: ——— ———  ——— ———
   Day #  evening #

Times when you are in classes and/or at work:

Thank you for your assistance and cooperation in completing this questionnaire.

Please place in enclosed envelope, and return through campus mail or bring to 210 Marston.
APPENDIX H. HUMAN SUBJECTS FORM
Checklist for Attachments and Time Schedule

The following are attached (please check):

12. ☑ Letter or written statement to subjects indicating clearly:
   a) purpose of the research
   b) the use of any identifier codes (names, #s), how they will be used, and when they will be
      removed (see Item 17)
   c) an estimate of time needed for participation in the research and the place
   d) if applicable, location of the research activity
   e) how you will ensure confidentiality
   f) in a longitudinal study, note when and how you will contact subjects later
   g) participation is voluntary; nonparticipation will not affect evaluations of the subject

13. ☑ Consent form (if applicable)

14. ☐ Letter of approval for research from cooperating organizations or institutions (if applicable)

15. ☑ Data-gathering instruments

16. Anticipated dates for contact with subjects:
   First Contact .................. Last Contact ..................
   April/May 1992 .................. Until all data are collected
   Month/Day/Year .................. Month/Day/Year

17. If applicable: anticipated date that identifiers will be removed from completed survey instruments and/or audio or visual
    tapes will be erased:
    January 1993 (Audio-tapes will be erased)
    Month/Day/Year

18. Signature of Departmental Executive Officer: Date
    Barry H. Shepherd 4/19/92
    Department or Administrative Unit
    Professional Studies

19. Decision of the University Human Subjects Review Committee:
    ☑ Project Approved    ☐ Project Not Approved    ☐ No Action Required

    Patricia M. Keith 4/19/92
    Name of Committee Chairperson
    Signature of Committee Chairperson
APPENDIX I. SELECTED TRANSCRIPT DATA
## SELECTED TRANSCRIPT DATA

**An Interpretive Case Study of Perceptions and Experiences of Undergraduate Women in Engineering at Iowa State University**

<table>
<thead>
<tr>
<th>Respondent</th>
<th>Unit</th>
<th>Category</th>
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<tr>
<td>Ann</td>
<td>Poor high school preparation in calculus and physics</td>
<td>Academic Preparation</td>
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<tr>
<td></td>
<td>Interest in math and drafting</td>
<td>Personal Fit with Major</td>
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<td>Parental encouragement and parental background</td>
<td>Support and Influence</td>
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<td></td>
<td>Interest in practical aspects of engineering</td>
<td>Personal Fit</td>
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<td></td>
<td>Limited internship opportunities in major</td>
<td>Internal Support</td>
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</table>
Annette, Side 1

A: Today's date is April 28th. This is an interview for the study on perceptions and experiences of undergraduate women in engineering at Iowa State University. Would you go ahead and just introduce yourself for the tape please?

S: My name is Ann. I'm a sophomore majoring in Industrial Engineering and I also am pursuing a minor in Environmental Studies.

A: Okay. Thanks. Ann, could you share just share some general biographical information about yourself? Where you are from, where you grew up, where you went to school, what kinds of experiences you had coming through school that helped you to know that you wanted to become an engineer?

S: Um, the last six years I lived in Shenandoah, Iowa, which is a small town of about 7,000 people and there are about a 100 people in my class at school so I didn't have a lot of experience in calculus, physics and stuff until I came up here but I'd always been interested in space relations and just mechanical type things and drafting and stuff like that so I just thought engineering, I might try it.

A: Was there something in particular that you learned in your high school or you had experience with that made you know that was what you wanted to do?

S: I knew I wanted to go into something like engineering. I didn't really know what engineering was, but I like drafting and I like math and I like science.

A: Did you have a good high school program in those subject areas?

S: It was so so. It wasn't great. Like I said, I didn't have any calculus experience at all, which makes it kind of hard.
A: Did you have teachers or counselors at your school that encouraged you to consider engineering?

S: Not really. Basically it was my parents that pushed me.

A: Okay. I'll come back to some of that later. You talked about the influence of your parents. Could you talk a little bit more about what kinds of support or encouragement you've gotten from them to pursue engineering as a major?

S: Basically I guess it was hard for them to push me into something because they didn't really know what engineering was either, but they knew about as much as I did and that it sounded like it was something that I was interested in. Being that my mom is a teacher and my dad is a businessman, they didn't have any idea really what all it entailed so when I have problems with my classes, they don't always understand exactly.

A: Do they have concerns about you going into a field that has traditionally been dominated by males?

S: My mother did. My father didn't. My dad thought it was great.

A: What kinds of concerns did your mother have?

S: She was always worried that it would be too hard and too ... there'd be too much competition, I guess.

A: Did she ever suggest that any alternative fields you might want to go into? Did she ever say why don't you look at this or that?

S: When I was a freshman up here, I almost switched my major to landscape architecture because I like drafting and drawing and stuff and she kind of pushed that for a while too but basically it was my decision, but I stuck with engineering.
A: And tell me again, at what point did you decide in your high school days that you wanted to be an engineer. Was that junior year or?

S: Actually I didn’t even know engineering existed until like my junior year. I wanted to be an astronaut so I came up here and I was in aerospace engineering and I switched to industrial.

A: Could you talk a little bit about yourself more? Once you have graduated from Iowa State University, what kinds of things do you want to be doing, say three - five years down the road? What do you see as your long term plan?

S: I’d like to be working in a production type factory and I don’t want to be sitting down at a desk eight hours a day. I’d like to be up and about and looking around and also seeing like a collaboration of different jobs.

A: Are you at this point able to find out what kinds of opportunities will be available for you say three - five years down the road? Are you getting that kind of information?

S: Pretty much so. I just got an internship this summer working in Pella windows factory. Hopefully I’ll learn something from that.

A: Is this something that people in your, industrial engineering, is this something that students typically at the end of your sophomore year, do an internship?

S: I think a lot of them usually wait, but I kind of needed a job and they just built a factory there and I kind of pursued it.

A: Okay. So you get both the experience and you get paid for it.

S: Yes.
A: That's good to hear. When you mentioned earlier that you switched from aerospace engineering, when you changed your mind about aerospace engineering and decided to go into industrial engineering, could you talk a little bit about why not to pursue aerospace engineering?

S: Basically because when I started in the physics class up here I decided that I knew aerospace would be a lot of physics, mostly physics, and that just didn't interest me.

A: So it just took taking one class to know that?

S: Yeah. Basically. I had a little bit of physics in high school and it was kind of interesting but when I got up here it was just like ...

A: The content of the course just wasn't what you wanted?

S: Yeah.

A: Okay.

S: It's interesting, but I sat and thought and figured I didn't want to do this the rest of my life.

A: Could you talk a little bit about when you first ... how did you come to decide on Iowa State as the place you wanted to go to school?

S: basically it's close and it's a science and technology oriented school. I knew pretty much was sure that was the type of thing I was going to be going into, not necessarily engineering. Just figured that would be the best.

A: When you first knew that you were coming to Iowa State, were there certain things that you had expectations about, either the school or your academic program, your major area that you thought that this was probably the way things are going to
be? Are there certain things you came in with on your mind that were on your mind?

S: Yes and no. I had a couple friends that came up here from my high school that I talked to and I knew the society of women engineers puts on a career conference for high schoolers and I came up to that a couple of times and you kind of get a lot of background stuff.

A: So have your expectations been really different ... I mean, has the reality been real different from your expectations coming in?

S: I expected it pretty much to be tough and it is and there are a few things that are different now and then. Pretty much the same as I expected.

A: What are those things that are different than what you expected?

S: Um, I guess the problem with getting different professors up here and how that can kind of make it or break it for you. That was kind of new to me, because in high school it is basically one teacher teaches each class and you didn’t really have a choice so that was basically new and something that I knew would happen, but I didn’t expect it to be that influential in the classes.

A: In other words, are you saying there are certain professors that you want to take classes with and certain ones you don’t want to take classes with?

S: Yes.

A: And trying to figure all that out was a?

S: Right.

A: What would have helped you, now that you look back on it, for those things that were real different than you expected, what would have helped you be more comfortable coming in?
APPENDIX J. SELECTED FACTORS CONTRIBUTING TO UNDERREPRESENTATION OF WOMEN
**Program for Women in Science and Engineering**

Question #16A: What do you think has contributed AT LEAST SOME to the underrepresentation of women in technical fields?

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<thead>
<tr>
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<th>FCS</th>
<th>LAS</th>
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<td>41.7 23</td>
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<td>53.6 30</td>
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APPENDIX K. FACTORS PROBLEMATIC FOR WOMEN IN TECHNICAL FIELDS
<table>
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