The Pennsylvania State University

The Graduate School

College of Education

FACTORS AFFECTING CLASSROOM INVOLVEMENT OF WOMEN ENGINEERING STUDENTS

A Thesis in

Counselor Education

by

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Submitted in Partial Fulfillment
of the Requirements
for the Degree of

Doctor of Education

August 2003

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ABSTRACT

The "chilly classroom climate" is a term created by Bernice Sandler and Roberta Hall in 1982 to describe the causes and consequences related to lack of confidence, lack of acknowledgment and devaluation of female students. Research implies the chilly classroom climate is especially a problem for female students in engineering. This research project focused on the classroom climate for female engineering students in the hopes to identify strategies to recruit, enroll and retain more women in this field.

This study examined the relationships between women's level of gender identity, learning styles preference, and perceptions of the classroom environment and how these factors affected each other as well as their collective influence on women's self-reported level of classroom involvement in core engineering courses. Participants were 146 undergraduate female engineering students from the University Park campus, of The Pennsylvania State University.

The study included four assessment instruments and one demographic information sheet. The demographic information sheet obtained relevant background information, including race/ethnicity, age, major, class standing, cumulative GPA, and socioeconomic status. The Myers-Briggs Type Indicator (MBTI) Form M assessed students' learning style preference. The Salter Environmental Type Assessment (SETA) Experimental Form B was used to assess students' perceptions of the classroom environment. The Gender Interconnection Scale (GIS) measured the students' gender connection to men and women. The Classroom Involvement Survey (CIS) was designed to assess the level of students' participation in classroom environments focusing on their

self-reported behaviors pertaining to involvement. Classroom involvement included aspects of student participation in and out of class.

Stepwise regression analysis was used to determine whether the independent variables (learning style, classroom environment and gender connection) explained a statistically significant amount of variance in the dependent variable (students' level of classroom involvement). The initial, fully saturated regression model was a significant model, which accounted for 48% of the variance in the dependent variable, level of student classroom involvement. However, because all independent variables that were entered into the initial regression equation were not significant, a reduced or more parsimonious model was developed. Three factors were significant variables in explaining variance in the level of classroom involvement. The SETA-TF, GIS Male and SETA-EI dimensions explained 45% of the variance as indicated by the R^2 value of .448 and an F-value of 38.40 ($p < .001$).

The regression results were consistent with previous findings that indicate higher SETA-TF values were associated with higher perceived classroom involvement values. The SETA-TF variable explained 40% of the variance in the dependent variable, classroom involvement. In other words, the more "feeling" oriented classrooms resulted in statistically significantly more self-reported student involvement. The GIS variable explained 3.3% of the variance in the dependent variable and was significant at the .007 level. The regression results indicated that higher GIS male interconnection values were associated with higher perceived classroom involvement values. Women who identified more with men had higher classroom involvement values than women who identified more with women. The SETA-EI variable approached statistical significance and explained .3% (p = .051) of the variance in the dependent variable, classroom involvement. The regression results indicate that as SETA–EI values increased, classroom environment values decreased. In other words, students participated more in extraverted classes.

Based on the results of this study, strategies for creating warmer, more extraverted and feeling oriented classroom environments that are more open and encouraging to student involvement are discussed. Such environments can make a significant difference in the recruitment, enrollment and retention of engineering students and especially for women engineering students.

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Completing the dissertation is not a project anyone accomplishes alone. For me, there were dozens of special people who inspired, supported and encouraged me throughout this time of uncertainty, perseverance and discipline. Among them were my doctoral committee, my friends and my family.

I owe a great deal of gratitude to my committee chair, adviser, teacher and mentor Dr. Daniel Salter. He guided me through my master's degree and encouraged me to pursue the doctoral degree. Without his continuous encouragement, I may not have had the courage or confidence to attempt the doctoral degree.

I am very fortunate to have assembled the most supportive, dynamic and considerate committee of experts in their fields. Dr. Catharina "Tineke" Cunning has been a mentor and role model for me. Whenever I doubted my abilities, her words of inspiration and encouragement would help to steer me back on track. Dr. James Stewart showed his belief in me the very first time we met, when he advised me to someday consider earning the doctoral degree. Finally, Dr. Edgar Yoder has been an inspiring teacher and mentor for me. Dr. Yoder made the most challenging component of the dissertation, the methodology and statistics into one of the most exciting and easy processes. His patience, thoughtfulness and dedication to me and my project will never be forgotten.

This endeavor would not have been completed without the support of my supervisor and friend, Amy Freeman. She gave me the support and confidence to complete this project. Also, my colleague, Ida O'Donald deserves thanks for filling in for me at the office when I needed to stay home and work on this project.

Special thanks goes out to the Director, Barbara Bogue for her belief in my project and willingness to assist. Also, I want to thank all the women engineering students who invested their time to participate in my study. I hope my findings will somehow shed some light on the concerns raised and make their future educational careers more enjoyable.

My friends played a great role in motivating me to pursue this huge project. I want to thank them all for their understanding and patience while I focused on finishing my degree. Thank you to İlknur and Serhat for your support and understanding on those times when I studied during our visits. Thank you to Ebru for giving up your playtime to study with me instead.

I thank my family for their support throughout the years. To my Dad who never realized it but he taught me to be independent, ambitious, and strong-willed. Special thanks to my Mom who always encouraged me to pursue my goals and had the confidence in me that I did not always possess myself. Her admirable work ethic and devotion to us made me strive harder during those times of uncertainty. Also, thank you to my brother Alvin, sister Debbie and brother-in-law, Shameer who looked up to me which made me want to become the best role model for them.

Finally, I want to thank my husband Serdar and his family, Mom, Dad, Çağdas, Özgür and Özge for their confidence and support. Words cannot express my gratitude to Serdar for his unconditional love and devotion throughout this process. His patience and love gave me the strength to focus and continue. For being my teacher, my counselor, my computer consultant, and my best friend during this adventure, thank you Serdar.

CHAPTER 1

INTRODUCTION

Historical Context

"Shall a girl receive the same education as a boy, in the same college, with the same instructors, and be awarded the same degree?" (Butcher, 1989, p. 33). These questions stirred a heated debate in 1837, at Oberlin College, in Oberlin, Ohio. An all-male institution at the time, Oberlin shocked the nation by opening its doors to female students. Four women enrolled and four years later, three of those students graduated with their A. B. (Artium Baccalaureatus, equivalent to a Bachelor of Arts degree today). As the first female students to graduate from an American institution of higher education (Butcher, 1989), they opened the doors for many women to follow, which led to the beginning of "coeducation".

The rise of coeducational institutions did not come quickly or easily. Rather, it took years of confrontation from women's rights newspapers to "shame" institutions into adopting coeducational practices. After years of reprimanding institutions and making women's right to equal education a public issue, educational institutions finally agreed to change. During the mid-1850s, the papers promoted the benefits of coeducation and reassured the readers of its positive effects. Without the intervention of these women's rights newspapers, the beginning of coeducation may have been delayed by a few more decades, which would have resulted in further loss of women's talents and skills. If change had not occurred, today women may not be in as many positions of power and leadership.

After the Civil War, coeducation was adopted on a nationwide scale due to basic economic needs. Coeducation seemed to be the best alternative for poor states, which could not afford to offer separate educational institutions for men and women. In 1870, there existed 169 (29%) coeducational American colleges and universities. That figure increased to 465 (43%) of the country's 1,082 colleges and universities by 1890. As coeducational institutions were on the rise, single-sex schools were being highly criticized and labeled as inferior (Butcher, 1989). At that time, women's colleges were not provided with the necessary resources to give female students an equivalent education as male students. Also, the curriculum was geared toward stereotypical female fields and did not allow female students access to traditional male dominated careers (Butcher).

In 1894, a report from the State of New York announced that women made up 56% of the state's collegiate enrollment. Surprisingly, this news was received with mixed emotions. As women's rights advocates celebrated, many others were concerned that this rise in female students would somehow disrupt social order. This fear lead to a backlash and scorn of "overeducated women". The progress of coeducation was temporarily slowed due to this backlash.

Interestingly, craniology, which was considered a science, confirmed popular sex biases of that time. It was believed that larger brain sizes were equivalent to higher levels of intelligence and men tend to have larger heads than women. By the early 1900s, craniology died out however biological explanations for why women were inferior to men began to surface. Dr. Edward Clarke wrote a book entitled *Sex in Education* in which he claimed that coeducation was harmful to the reproductive health of women. He asserted that the reproductive organs, which develop during the teenage years, would be damaged by education. “Blood would be diverted from these reproductive organs to the brain which would result in ‘monstrous brains and puny bodies…flowing thought and constipated bowels’” (as cited in Sadker & Sadker, 1994, p. 30). Clarke’s answer to this dilemma was the less demanding sex-segregated schools for men and women. Women would not have to cope with the high stress, challenging curriculum and critical thinking that comes with studying male interests.

Another milestone for women in higher education came with the passage of Title IX in 1972 (The Chronicle of Higher Education, 2002), which resulted in great strides for female graduate and undergraduate students in access to higher education. Although today, women attend college in greater numbers than men, they are still underrepresented in disciplines such as science, mathematics and engineering (Orenstein, 1994; Swim & Stagnor, 1998b); The Chronicle of Higher Education, 2002). Surprisingly, Schinzel (1999) noted that over the past 15-20 years, women within industrially developed countries have been less represented in these fields when compared to women within developing countries. In 1995, women in the U. S. represented 32% of math and computer specialists, 27% of natural scientists, and 11% of engineers (Martin, 1999). Women compose only 15-20% of undergraduate computer science majors and only 17% of women take the computer science Advanced Placement tests in high school (Margolis, Fisher, & Miller, 2000). The proportion of women receiving bachelor’s degrees in computer and information sciences has declined almost 10% from 1999-2000 (The Chronicle of Higher Education, 2002). This gap appears to be getting wider today.

Occupational Segregation

The U. S. workforce continues to be almost entirely segregated by gender. Many occupations are either predominately male or female (Ehrhart & Sandler, 1987; Sadker, 2000). While more women are found in service jobs, labeled the "pink collar ghetto" (retail sales, clerical, etc.), more men are found in higher paying, more prestigious jobs in such fields as medicine, law, computer science, mathematics and engineering. Regardless of whether they are married or have children, most women work outside the home and will probably continue to do so for the rest of their working careers. However, many of these women have jobs with low salaries and very little opportunity for career advancement, regardless of whether they possess college degrees. Women already in male-dominated fields experience limited opportunities for advancement, discriminatory employment practices and unequal pay. Science and technology continually changes the way people live and with a shortage of women with expertise in these areas society is losing their valuable perspectives in our highly increasing technological future (Ehrhart & Sandler, 1987). By not using women's talents, society loses their great contributions.

Gender-Dominated Careers

Societal biases based on gender combined with gender differences in mathematical confidence may create an attrition mechanism resulting in gender-dominated fields. Male dominated fields such as engineering, technology, mathematical and computer science, natural science, health diagnosing occupations, legal, executive, administrative and managerial positions (Barber, 1995; Murray, Meinholdt, & Bergmann,1999) do not foster positive working and learning environments for women (McGeveran, 2002; Meggett, 1997). Such environments may lead to the lack of women in science and engineering careers. According to the Bureau of Labor Statistics table, "Employed Persons in the U. S., by Occupation and Sex, 1995, 2000", published in the *World Almanac and Book of Facts 2002*, women made up only 10.9% of U. S. engineers, (207,000 women and 1,886,000 men) (McGeveran, 2002).

Men tend to choose accommodating work environments that are highly rewarding in terms of professional status and income potential while women tend to choose supportive environments which hold externally low rewards (Hearn & Olzak, 1981; Rienzi, Allen, Sarmiento, & McMillin, 1993; Seymour & Hewitt, 1997). Such traditional female occupations include nursing, social-work, non-college or university teaching, sales, clerical and administrative support, and service (Jacobs, 1989; McGeveran, 2002). These occupations result in lower income and status (Bressler & Wendell, 1980; Ehrhart & Sandler, 1987). In 1997, the Bureau of Labor Statistics reported that White women, who worked full-time, earned 75% of White men's salary while the percentages were 64% and 54% for Black and Hispanic women respectively (Keaveny, 1999). These societal inequities can be traced back before women entered the job market to their educational experiences.

<u>Gender Bias in Education</u>

Most male and female students now share the same institutions, classrooms and faculty, yet female students may have considerably different learning experiences when compared to their male counterparts (Chapman, 1989; Hall & Sandler, 1982; Prentice, 2000; Sadker & Sadker, 1994;). Therefore, female students may not equally benefit from the educational opportunities on the college campus. The "chilly classroom climate" coined by Hall & Sandler, refers to the combination of everyday practices, which often hinder women's full participation within a university, therefore blocking their potential to succeed (Prentice). The chilly classroom appears to be an especially prevalent problem in the sciences (Hall & Sandler, 1984, 1986; Seymour & Hewitt, 1997).

Involvement in the classroom is critical to learning. Students who participate actively in the classroom tend to enjoy the learning process and possess higher levels of self-esteem. These students also learn to perceive mistakes or failures as a learning tool, and learn much more than students who do not actively participate (Orenstein, 1994). Unfortunately, girls learn at a young age that their opinions and ideas are not equally valued when compared to boys so they choose to remain silent in the classroom (Belenky, Clinchy, Goldberger & Tarule, 1986).

From elementary school, girls perceive that women are not visible as contributors to society. When instructors ignore girls and encourage boys in the classroom, these girls learn to be silent. Silent students grow up into silent adults (Belenky et al., 1986). As a result, they steer away from math and science, where they encounter such differential treatment more often. Instead, they learn to value “feminine” qualities, such as neatness and quietness, more than assertiveness and innovation (Sadker & Sadker, 1994).

According to Gabriel and Smithson (1990), the differential treatment of boys and girls affects their self-perceptions. For instance, when they are treated with less respect than boys, girls lose confidence in their abilities and this affects their participation in the classroom (Sadker, 2000). While most instructors want to treat their students fairly, some may intentionally or unintentionally treat male and female students differently in the classroom. Although these types of biases are not as strong as in the past, they tend to continue in more subtle forms (Gabriel & Smithson, 1990; Hayes & Flannery, 2000). Such biased behaviors can be so subtle that it may go unnoticed (Chapman, 1989; Cranston, 1989; Prentice, 2000; Sadker & Sadker, 1994; Sandler, Silverberg & Hall, 1999).

Understanding why women remain underrepresented in science, mathematics and engineering majors may at first glance appear puzzling. Starting before ninth grade, both girls and boys seem identical in their academic performance in math and science courses. Yet, a big plunge in girls’ mathematical interests begins in high school and is still evident in college. While they tend to have slightly higher predicted college grade point average (G. P. A.) scores when compared to their male peers (i.e., 3.05 versus 2.99 in engineering) (Seymour & Hewitt, 1997), female students still do not persist in their math, science and engineering majors at the rates of men. The further they get in their education, girls take fewer and fewer math and science based courses. By the time young women reach college, the ratio of men to women intending to major in engineering in college is five to six men for every one woman (Seymour & Hewitt, 1997).

Inside the classroom women are at a disadvantage because they do not see female faculty role models (Chapman, 1989; Prentice, 2000). Without female role models and mentors, female students are less likely to pursue graduate education (Sadker & Sadker, 1994) thus the cycle perpetuates itself. Women faculty face more challenges in achieving tenure especially when their prime tenure-track years are also their most optimal childbearing years. Higher educational institutions do not always consider allowing these women more time to attain tenure as well as creating campus childcare facilities for these working mothers (Sadker & Sadker).

Another explanation why so fewer women attend graduate school could be the fact that women's contributions are not equally appreciated and rewarded in the classroom. Also, most faculty members tend to favor male students over female students by behaving in a more positive manner toward male students (Cranston, 1989; Hall & Sandler, 1982). For instance, instructors may subconsciously make more eye contact with men, interrupt men less than women ask higher-level questions to men and help them to find the correct answers. At the same time, instructors give women less critical feedback on their answers and address the class as if women were not present such as using the generic "he" in examples (Sandler et al., 1999; Schnellmann & Gibbons, 1984). In conducting class discussions, some instructors' behaviors discourage female students from participating. Instructors' behaviors that can have this effect include ignoring female students while recognizing male students even when women clearly volunteer to participate; calling directly on male students but not on female students; calling male students by name more often than female students; "coaching" men but not women in working toward a fuller answer by probing males for additional elaboration or explanation; and crediting males' comments to their authorship (Gabriel & Smithson, 1990; Sandler & Hall). Furthermore, while male students benefit from formal and informal mentoring relationships with male faculty (e.g., serving as a research assistant, co-presenting at a conference, playing basketball or golf), female students are typically shut out from these supportive relationships. Probably one of the most evident examples of gender bias would be female students who are married or have children. These women tend to be accused of not being serious about their careers while male students who are married or have children do not receive this type of scrutiny (Murray et al., 1999).

Graduate Study and Faculty Representation

Women's learning has been influenced by their increasing access to higher education in recent years, in which they have made great strides. Their numbers in higher education increased from 3.5 million to 7.9 million from 1970 to 1993 (Kopka & Korb, 1996 as cited in Hayes & Flannery, 2000). Although women outnumber men in undergraduate education, they are still underrepresented in graduate programs (both masters and doctoral) and among university faculty (Prentice, 2000). Women's under-representation in graduate education may be a direct effect of the lack of female representation on the faculty (Prentice, 2000). Also, they tend to choose very different areas of study when compared to men. In graduate school, this pattern of choosing traditionally female fields is very clear. In 1992-1993, women received 59 percent of the education doctoral degrees but only 11 percent of the engineering degrees. Why they choose careers that lead to lower financial status and respect may appear perplexing (Hayes & Flannery, 2000). Society has not encouraged women to pursue male-dominated fields (Seymour & Hewitt, 1997). Women in science and engineering face greater disparity in salary and promotion, which only increases with time (Valian, 1999).

Women's self-image suffers because they are praised and encouraged less in the classroom as well as in society, which results in the low number of women in engineering and science (Sandler, Silverberg & Hall, 1999). This pattern leads to an unrelenting cycle in engineering and science. The low number of female students and female faculty in engineering and science creates an atmosphere that builds upon the chilly climate where women are treated as tokens. They are not viewed as serious individuals with intellectual abilities (Sandler, Silverberg & Hall). All these factors combined could explain why we see so few women pursuing their graduate degrees, which also explains the lack of women on the university faculty (Prentice, 2000).

Feminist Pedagogies

Feminist pedagogy refers to the process of teaching and learning particularly in the facilitation of women’s learning. It focuses on recognizing the gender differences of our experiences, both personal and public, in stories. The three main elements of feminist pedagogy include the psychological models, the structural models, and the post structural models. The psychological models focus on women's psychological development as learners; the structural models focus on challenging social structures such as gender, race, and class privilege and other means of oppression that affects women's learning; the post structural models focus on how social structures such as race, gender and class shape our identity and development and they can be used in the educational setting to assist social changes (Hayes & Flannery, 2000).

In *Women's Ways of Knowing* (Belenky et al., 1986), the authors indicate the importance of sharing authority by the instructor or facilitator with the learners or students. The similarities among the women were accentuated as well as the fact that most of the women learned best in conditions that emphasized relationship, connection, affectivity and rationality. It is also important for students to understand that their instructors have to work very hard to prepare lectures, write papers and understand complex theories. The fact that instructors do their deep struggling and thinking outside of the classroom tends to give female students the false impression that learning and understanding comes easy for others. For students to realize they are capable of developing their own theories and of taking risks in the classroom by verbalizing their thoughts, instructors need to set the example. Sharing their experiences of how they come to learn is extremely critical in fields such as science and engineering where women are the minority with male professors doing the majority of teaching. Seeing women role models as professors succeed and fail as well as male professors succeed and fail at solving problems, would give female students the confidence to realize that we are all human and imperfect. More importantly, they would feel empowered by the realization that they too can solve complex problems, create models and theories and eloquently write scientific papers (Belenky et al.).

Curriculum in Engineering

This study focused specifically on the perceived classroom environment and its relation to the level of participation for women undergraduate students in engineering. The engineering pedagogy appears to be very rigorous, focusing on problem solving, which involve higher-level mathematics and reasoning skills (Murray et al., 1999). Program sequence is very structured and tightly packed with chemistry, physics, calculus and essential core and advanced engineering courses. Most of these core courses are fast-paced, academically challenging, and consists of hundreds of students. Faculty members frequently interpret complaints from students about course workload as proof these students are lacking in ability. Since female students tend to ask more questions and request help, they are often times seen as less competent than male students (Murray et al.,).

It is equally important to pay attention to what is being taught as to how it is being taught. In the United States, the curriculum at most institutions of higher education was designed by men and continue to be managed by men. The curriculum of higher education has focused on the male experience and as a result, omitted or distorted the history of women (Chapman, 1989; Gabriel & Smithson, 1990; Sandler et al., 1982). The history and accomplishments of racial minorities and women have frequently been misrepresented or absent from textbooks and the academic curriculum (Chapman, 1989;

Loewen, 1995). The curriculum marginalizes women by not discussing their experiences or perspectives.

Attrition in Engineering

Both male and female students complain of the “weeding-out” system practiced by many faculty members in science and engineering (Murray et al., 1999). The philosophy behind this method is that only the brightest will succeed and those who do, deserve to become scientists and engineers. This method tends to be most used in the prerequisite core engineering courses, where an unrealistic amount of course material is covered, excessive homework is assigned, exams are extremely difficult, and severe grading criteria are implemented.

Our culture holds the stereotypic belief that women have less mathematical ability than men. Unfortunately, faculty members see the minority status of women in engineering as support for this stereotype. The fact that in 1995, only 3% of engineering faculty consisted of women and the lack of female students in engineering majors explain why male faculty may not be eager to offer help to female students. Such faculty members expect women to fail. Similarly, when male students encounter a female professor this same manner of disrespect emerges. They tend to question their female faculty’s credentials and challenge their expertise (Murray et al., 1999).

On some level, the overall climate of science and engineering may account for many of the problems experienced by women (Hall & Sandler, 1982; 1986). Undergraduate attrition rates in science and engineering for both men and women are high (Seymour & Hewitt, 1997). Among the various reasons given by both male and female students for leaving engineering include boring courses, fast-paced curriculum, unrealistically difficult or unrelated exams, heavy workloads, inadequate high school preparation, large classes, aggressive competition, disorganized, unapproachable instructors, the "weed out" process, overly broad curriculum, and poor teaching strategies (Murray et al., 1999; Strenta, Elliott, Adair, Matier, & Scott 1994). More than one-third of the students who leave the engineering and science fields credit their attrition to poor teaching by faculty (Seymour & Hewitt). To illustrate, the proportion of women receiving bachelor's degrees in computer and information sciences has declined from 37% in 1984 to 28% in 1999-2000 (The Chronicle of Higher Education, 2002). It is very plausible that teaching methods outlined above may explain this phenomenon (Colbeck, Cabrera & Terenzini, 2000).

<u>Significant Trends</u>

Research clearly demonstrates the attrition of women from the College of Engineering, especially during their first and second years. Some of these findings are:

- Of those students who remain in their original engineering major of choice, 86% are men and 14% are women (Seymour & Hewitt, 1997).
- Women's self-confidence and belief that they can succeed in this field seem to increase after their college sophomore year (Heller, Puff & Mills, 1985).

- An alarming forty-five percent of women leave the College of Engineering for reasons other than academic, where upon leaving, they had maintained an ‘A’ or a ‘B’ grade point average (Seymour & Hewitt, 1997).

Such provocative research findings on the detriments to women’s success has lead this researcher to focus on addressing this issue in the core engineering courses, which are taken in those first two years of engineering students’ program of study.

Overall Impact

While higher education is now more accessible to female students, campus climate and classroom environment in science, technology and engineering are far from welcoming. Clearly, blatant discrimination against women has declined, however, subtle forms of discouragement based on gender still exists (Barber, 1995). One reason is the differential treatment of women students by faculty. Although the differential treatment by faculty is subtle, such treatment leads to devastating results for women students when they are cumulative. As a result, women’s confidence in their ability is diminished, thus lowering their academic and career aspirations.

Educators will not see a significant number of women in science, technology, and engineering until the educational system corrects its current inequities. Instructors need to take active steps to diminish gender stereotypes from their personal beliefs, within the classroom and extinguish such stereotypes from their exams. In doing so, female students will maintain a healthy level of confidence in their math and science ability as male students, thus resulting in more female students pursuing nontraditional careers.

Only then will colleges see more female role models as science and engineering faculty members, resulting in more female students pursuing and succeeding in these careers.

Statement of the Problem

The purposes of this study are to identify the factors that may contribute to attrition of female students and to make concrete recommendations in order to improve the retention rates of women in engineering. Three major elements, which have been identified in creating the "chilly classroom climate", are student-instructor interactions, female faculty representation, and the academic curriculum (Hall & Sandler, 1982; Sandler, Silverberg, & Hall, 1999). In this dissertation, the focus was on student-instructor interactions, since this is the area which seems to have the strongest influence on women's learning outcomes within the classroom and it is the area in which intervention can be most effective (Chapman, 1989; Cranston, 1989; Prentice, 2000; Sadker & Sadker, 1994; Hall & Sandler, 1982; Sandler, Silverberg, & Hall, 1999; Williams, 1971).

It is critical to understand whether the factors affecting female students' retention and success in engineering are inherent in their personality or a part of their environment. In the present study, this researcher examined the relationship between women's perception of the classroom climate, students' learning styles, and their gender interconnection and how these variables affect each other as well as students' level of classroom involvement in core engineering courses. The Myers-Briggs Type Indicator (MBTI) Form M (Myers, 1998) was used to measure learning styles, the Gender

Interconnection Scale (Swim, 2002a) was used to measure level of gender identity/interconnection and the Salter Environmental Type Assessment (SETA) Experimental Form B (Salter, 2000a) was used to measure the classroom environment while the Classroom Involvement Scale (CIS) was developed to measure the level of classroom involvement. A demographic information sheet was also included in the data collection.

Summary

Research in this area is critical to the field because it will bring society one step closer to understanding why women do not pursue nontraditional fields such as science and engineering at the level that men do. Research implies the chilly classroom climate is especially a problem for female students in engineering. This research project focused on the classroom climate for female engineering students in the hopes to identify strategies to recruit, enroll and retain more women in this field. In addition, this researcher hopes the data from this study will explain women's experiences in engineering and assist in strategizing methods in which to create a warmer more supportive classroom environment of female engineering students.

Practical implications of the present project include a) giving educators a clearer understanding of ways to design methods to counter the harmful effects of the present chilly classroom climate phenomenon in higher education; and b) improving educators' understanding of female students' learning styles, preferences in teaching styles and styles of communication. Most importantly, the number of women in engineering may increase due to the changes made; it may help to tear down some societal gender stereotypes; more female students may consider and have confidence that they could succeed in nontraditional fields at an earlier age; and finally, such a study could give a clear rationale for the existence of Women in Engineering Programs and women's support centers on campus.

The potential value of this study may include a) an explanation of how the classroom environment influences women's involvement in higher education and future career involvement, therefore increasing their contributions to society; b) the adoption of a fair and equitable teaching and learning environment for female students within the College of Engineering, thus diminishing the discrepancy in ratio of men to women in engineering; and c) the improvement of faculty teaching methods, teaching women to be more aware of their learning styles and steering administrators' policy decisions by demonstrating the importance of classroom environments to student learning.

CHAPTER 2

REVIEW OF LITERATURE

Chilly Classroom Climate

The "chilly classroom climate" is a term created by Bernice Sandler and Roberta Hall in 1982 to describe the causes and consequences related to lack of confidence, lack of acknowledgment and devaluation of female students. These factors result in the marginalization of female students within the college classroom. In Sandler and Hall's opinion, the faculty has a long way to go in order to provide a "warmer" and more welcoming atmosphere for female students (Gose, 1996). Overt gender discrimination has declined due to policies and procedures designed to end this problem (Kopp & Farr, 2000). Although today, higher education may be more accessible to female students (women now represent the majority of undergraduate students); access is not the equivalent to equitable treatment of women in higher education (Bischoping, 1998; Chapman, 1989; Cranston, 1989; Prentice, 2000; Sadker & Sadker, 1994).

When differential treatment in the classroom is taken as individual experiences, these behaviors may go unnoticed and may seem harmless. However, when they are collective, they could hurt female students' self-confidence, hinder their learning, classroom involvement and career ambitions (Sandler, Silverberg & Hall, 1982). Examples of classroom inequities are when instructors do not give enough time for female students to answer questions, or calling on males more than females (Cranston, 1989; Sandler & Hall, 1982; Schnellmann & Gibbons, 1984; Shmurak & Ratliff, 1994). In addition, instructors tend to use different responses for students' feedback by praising men's answers while merely accepting women's answers, which sends the subtle message to women that their contributions are not as significant or valuable. Also, instructors pay attention to the superficial attributes of female students such as appearance, social behavior and hand-writing, however they do not give this degree of attention to female students' participation in the classroom (Gabriel & Smithson, 1990; Sadker & Sadker, 1994). Other examples of such inequities that lead to differential treatment of male and female students by faculty and staff include lower expectations of female students, giving encouraging body language and facial expressions to male students' questions and comments, holding an attentive posture when males speak but the opposite when females speak, choosing locations near male students, favoring males when selecting student assistants, giving males more detailed instructions because it is expected that they succeed, and making direct sexual overtures to female students (Cranston; Sandler & Hall).

In her study, Cranston (1989) asked students to indicate how often they experienced 40 known different campus inequities, such as faculty ignoring male and female students and using humor at their expense. Both men and women agreed that women experienced more negative treatment and men reported fewer personal experiences (Cranston; Rienzi et al., 1993). Research has demonstrated how attributes of classrooms, such as inequities based on biology, can have negative effects for female students. If you are treated differently because of your gender, then you have to question the merits of being that gender.

This type of differential treatment is destructive to the development of women's self-confidence and accomplishment (Hall & Sandler, 1984; Gabriel & Smithson, 1990). Such negative treatment of female students is more acute in higher education, especially in male dominated majors such as mathematics, science and engineering, where the majority of faculty and students are men (Murray et al., 1999). These behaviors result in discouraging female students from seeking assistance outside of class; increasing attrition rates from technical majors; and diminishing career aspirations of female students (Sandler et al., 1982). Men who observe such biased behaviors by faculty toward female students have difficulty perceiving female students as their equal peers and have problems working with women in collaborative situations therefore never learning to accept and respect their female colleagues (Sandler et al.). Consequently, there are serious implications of the chilly climate to the detriment of all students, faculty, administrators and staff. Such a climate hinders the learning and development of female as well as male students (Sandler, Silverberg & Hall, 1999; Whitt, Edison, Pascarella, Nora, & Terenzini, 1999).

Attributes of the student, such as cognitive skills also affect students' perception of classroom climate. One study found that the chilly climate more negatively influenced those women who started college with higher levels of cognitive development when compared to women with lower levels of cognitive development upon college entrance. One possible explanation could be that women with higher levels of cognitive development may have had higher expectations from their college experiences. The more time women spent in such a chilly environment, the stronger the negative impact seemed to have been for them (Whitt et al., 1999).

'Chillier' Engineering Classrooms

Classroom participation strategies are especially important in the engineering classrooms, which tend to be "chillier" than other fields of study (Seymour & Hewitt, 1997). The research that exists on the chilly aspects of the college classroom environment is consistent with the chilly climate literature. As women succeed and progress in this field, they begin to learn that this field functions as a 'man's world'. Research in this area has indicated that the engineering culture values independence, tough-mindedness, objectivity and rational thought (Murray et al., 1999). Within engineering classrooms, female students' questions and ideas are frequently dismissed, they tend to be assigned the passive "secretarial" role for labs and class projects while male students take on active leadership roles. Also, female students are continuously teased and subjected to sexual jokes (Murray et al.).

Comprehending the engineering culture is the key to understanding women's struggles for success in this field. From childhood, boys are socialized to develop strong masculine qualities, which are critical in science. At the same time, girls are socialized to develop qualities, which will later hinder them from being taken seriously in science and engineering careers. Teaching women to assimilate to the culture of engineering may not be the solution to increasing gender equity in this field because in doing so we are telling them to change the essence of who they are while continuing this cycle of gender inequity. A solution to this problem may be to make major changes within the culture of engineering (Barber, 1995).

Drew and Work (1998) made the somewhat controversial claim that the classroom climate is no longer chilly for female students. They cited numerous studies that agreed with their assertion concluding that the chilly classroom climate no longer exists. They based their conclusion on evolving attitudes about women in society and their interpretation of the rise in female faculty and administrators as well as female students' assessment of their classroom participation and positive relationships with faculty. Nevertheless, they also found that female students did not interact informally with faculty after class or on research projects as much as male students and female students do not report as much gains in science, technology, and quantitative skills areas as compared to males.

Drew and Work administered the College Student Experiences Questionnaire (CSEQ) to 15,960 college students and found consistent results. The main flaws with such broad conclusions are that Drew and Work did not look specifically at women in science, mathematics and engineering, however, their claim loosely covered all fields of study. They did not ask specific questions about the classroom environment, instead they asked about campus climate, which does not give an accurate depiction of the classroom environment. They also made the "leap of faith" to say that society's perception of women has evolved, therefore, the classroom climate has improved for female students. Another flaw in their study was that the data were collected in one year (1994) and opinions expressed were students considering overall college experiences at one particular point in time. By pooling such data, extreme experiences of female students were eliminated, which could have made the data look better than they actually were for female students. Also, they contradicted their conclusion by stating female students do not interact informally with faculty after class at the rate of male students.

As enticing as it is to believe their findings, reality may not be so simple. If their conclusions are correct, then why are women still the minority in science, mathematics and engineering fields? Drew and Work's explanation for their finding is that there may be more acceptance of female students in the classroom due to the increasing proportion of female faculty members and administrators within higher education. They concluded by suggesting that differences in learning styles could be an area to revisit in explaining differences between students and in particular, differences between male and female students.

Learning Styles and Female Students

Learning styles have been defined in a variety of ways. They refer to individuals' preferences or strengths in perception and communication (Myers & Myers, 1995). They include cognitive, affective and physiological behaviors that indicate how learners perceive, interact, and respond to the environment. Each style of learning is equally valuable and has unique strengths. However, the preferences of one type may be a better fit for the skills and talents of a career or educational major than another type (Rosati, 1993). Learning preferences also seem to relate to gender (Myers et al., 1998).

The new scholarship on the education of women has suggested that female students may use learning strategies that are very different from the historical, male-oriented approach to teaching (Belenky et al., 1986; Sadker & Sadker, 1994). Women tend to be more collaborative, place a higher value on interpersonal relationships, use a different "voice" when making decisions (Gilligan, 1982), and communicate differently than men (Tannen, 1990). The incongruence of this female learning "style" with a prevailing male-oriented educational setting appears to lie at the heart of the chilly classroom dynamic. This incongruence is especially interesting for engineering classrooms, where men make up the majority (98%) of the faculty (Sadker & Sadker, 1994).

Other researchers do not believe there is a global learning style for women (Carskadon, 1994; Salter, 2003). Instead, they believe Jung's (1971) theory of psychological types T-F (thinking-feeling) dimensions play a significant role in describing women's learning styles. Specifically, the feeling preference reflects the style typically associated with the global female learning style.

Extraverted students think best while talking and they learn best in group-settings. They may have difficulty in introverted settings where they must sit still for long periods of time listening to lectures. Introverted students think best when they are alone and they like long periods of quiet time in order to concentrate and study since they do their best thinking when they have time to reflect. They enjoy lecture-based classes and appreciate time to prepare their responses to questions since they prefer to think before they speak (Jensen, 1987).

Persaud's (1999a) research on this population of students found that female engineering students were less inclined to be actively involved in classrooms that were thinking oriented. They were more inhibited when the environment was hostile or chilly.

This finding is similar to Williams' (1971) finding that passive students benefit when classroom participation is less threatening. Feeling classroom environments are not intimidating. Instead, they seem to be warm, open and encouraging of student-instructor and student-student interactions. Knowing that students would not be criticized or humiliated for being incorrect improves the overall classroom involvement for all students.

Jung's Theory of Psychological Types

Carl Jung devised a theory of human adaptation to the environment that has served as a basis to an important movement within education (Lawrence, 1993; Myers, McCaulley, Quenk & Hammer, 1998) with direct relevance to college students (Evans, Forney, Guido-DiBrito, 1998). Jung's theory of psychological types categorizes people by their orientations to one of two worlds. Extraverts (E) prefer the energy found in the outer world of people and things. Introverts (I) prefer the inner world of thoughts, feelings and perceptions. Manifested behaviors within these two worlds are the result of two processes: taking in information (perception) and making evaluations of it (judging). In regard to the perceptive (P) processes, people can either rely on a "sixth sense" (intuition) or on the information acquired from their five senses (sensing). People who primarily rely on the sensing (S) process tend to focus on observable facts by means of one or more of their five senses. People who rely on the intuition (N) process focus on meanings, relationships, and possibilities, which extend beyond the level of consciousness (Myers et al., 1998).

Of the two judging processes, thinking-oriented (T)) individuals are more inclined to use a logical; "if-then" approach to making decisions. They make decisions by relating ideas through logical connections. Thinking-oriented individuals value competency and want people to "play by the rules". Sometimes competitive, the analytical thinking types want to be treated equally and fairly (Myers et al., 1998; Myers & Myers, 1995). They rely on principles of cause and effect and heavily depend on objectivity and reason when making decisions (Myers et al.). People with a feeling (F) preference make value-oriented judgments and want to check objective data with their personal beliefs. Feeling types attempt to consider the effects of decisions on people, value equity over equality, and often strive for harmony in the environment. These individuals try to understand people and accommodate their well-being by anticipating how decisions will impact their lives.

It is important not to categorize these methods of judgment into an "all or none" box. People with thinking preferences are very capable of expressing feelings and accommodating the feelings of others just as people with feeling preferences are capable of being logical and analytical (Myers et al., 1998). Rather, these characteristics should be viewed as *preferences*. That is, when given a choice, a person would prefer one over the other.

Of special note, thinking-feeling preferences are not as evenly distributed between men and women, and it is the only dimension that illustrates a significant gender difference (Myers & Myers, 1995). While approximately 40% of the population have thinking preferences, nearly two thirds (63%) of thinkers are men. Of the 60% feeling types in the general population, over two thirds (68%) are women (Myers et al., 1998).

This distinct gender difference appears to be significant in relation to preferred learning styles in nontraditional fields.

Research on Type and Learning

A study comparing engineering students with liberal arts students found that 68% of engineering students preferred thinking, while only 54% of liberal arts students favored this preference (Myers et al., 1998). Another study by Carskadon & Cook (1982) of psychology students asked to rank descriptions of types resulted in the fact that students do not see all combinations of types as equally appealing as their reported type. For example, those who were extraverted-feeling types preferred these characteristics to the characteristics of the introverted-thinking types.

A Canadian study on learning styles of first year engineering men and women revealed some provocative findings (Rosati, 1993). More Canadian males possessing TJ, IJ and NT were successful in their first year engineering courses compared to the total male population of students. American male students who were successful in their first year engineering courses tended to be IJ. The academically stronger students succeeded in their first year engineering courses regardless of their type however for the academically weaker students, the INTJ types tended to be more successful. Unlike the men, a top type preference did not appear for the Canadian or American women. Successful women were more likely to be FJ and SF compared to successful males. Also, female students with the F preference tended to perform as well as males with the T preference. Of concern were the ESFP types, who were the least successful in first year engineering programs (Rosati). These findings imply that student retention in first year engineering programs might improve for all students and especially for female students if classroom activities appealed to the ESFP learning style preference.

Students' perception of teacher personality influences their perceptions of classroom environments. One study found extraversion, sensing, feeling and perceiving preferences were more often connected to positive classroom environments while introversion, intuitive, thinking, and judging preferences were less often connected (Barrett, 1989). In a study of teachers' learning styles, Kent and Fisher (1997) found similar results where students perceived extraverted teachers' classrooms to have higher levels of student cohesion. NP teachers' classrooms were viewed by students as too informal and encouraging independence, while SJ teachers were viewed as having strict, organized and task-oriented classrooms. It is empowering for teachers to know that they have a certain degree of control over the classroom environments they create and their influential effect on student learning (Barrett).

The majority of engineering instructors are males who are likely to have the ISTJ/INTJ learning preferences (Rosati, 1993). According to Welty (1989), most instructors teach in the manner they were taught, which is a lecture-based theoretical teaching style. However, it is common to see male engineering faculty who purposefully create extraverted-feeling classroom environments. For instructors to modify their methods of teaching to a more discussion based teaching style, they need to study and be familiar with their teaching material; anticipate and be prepared for questions from students; decide before class upon important concepts they want to present; outline their questions; have broad and specific questions prepared; create an outline on the board of the students' feedback and create a syllabus which include a class-by-class outline of topics, background reading assignments and questions for thought (Welty).

The T-F dimension was the focus for this study due to its significant gender differences of relevance to other gender-related variables. For example, psychological type may be another explanation of math ability, where the MBTI-TF scale shows clear gender differences. Since the majority of men (63%) prefer thinking while women prefer feeling (68%), occupations broken down by the T-F preference with math and engineering occupations consist of approximately 81% thinking preference (Wolverton, 1993). This fact led to the obvious interest in finding out which factors are responsible for this apparent difference in male and female occupations. Both gender and the T-F preference may affect mathematics self-efficacy and one can interact with the other (Wolverton, 1993).

Gender Identity

Students' level of gender identification may be another important piece of the learning style puzzle and was of primary concern in this particular study. Gender is the term used to describe male and female characteristics that are socially constructed which are very different from those characteristics that are biologically determined (person's sex). Generally, people are born either male or female however they learn to be girls/women and boys/men. In other words, how a person behaves is directly affected by how s/he is treated by others as well as how s/he perceives the behaviors of his/her role models. Gender appropriate behaviors, roles, activities, attitudes and relationships with others are taught and learned (Draft WHO Gender Policy, 1998; Hayes & Flannery, 2000).

According to Erikson (1968), identity is an unconscious process that links the individual to the social world as it unites personality. In other words, identity is a continuous "piecing together" of parts of the personality with realities of the social world in order for an individual to have an internal consistency and connectedness to the world (Josselson, 1983). Gender interconnection is a person's feelings and beliefs about whether s/he is a man or woman, or boy or girl and plays an important role in how a person functions in life (Kessler & McKenna, 1985).

Gender interconnection is especially relevant to women in engineering and the sciences, which have been male dominated professions (Murray et al., 1999). For example, women, who did not place female gender interconnection as a high priority in their self-concept performed better in solving mathematical problems compared to women who did possess high levels of female gender interconnection (Murray et al.). Also, girls who tend to like math and science possess higher levels of self-esteem and pursue less gender-stereotypical professions (Orenstein, 1994; Schmader, 2001; Spencer 1998). Such girls are more likely to be active participants in a classroom that is male dominated or have characteristics that favor male students.

Gender interconnection may be related to personality, which is why this researcher looked at the relationship between gender interconnection and learning styles which also seems related to sex. Previous research suggested that female students, who highly identified with the female gender identity, received lower performance scores in traditional male dominated fields such as engineering and mathematics (Schmader, 2001). Math ability is critically important in engineering and many other science fields. When tests were described as resulting in gender differences and revealing stereotypes, women did poorer than equally qualified men (Spencer et al., 1998). More generally, when there are negative stereotypes about a group, members of that group perform at a lower level under testing situations (Sanders, 2002; Schmader; Spencer et al.).

When women faced gender stereotypes about their math ability, they did not perform as well as men on difficult math tests that were said to show gender differences (women would not do as well as men). However, they did just as well as men on easier math tests, which were said to not show gender differences (Schmader, 2001). Another study found similar results where women under-performed on math tests they thought would demonstrate their lack of ability in math. Ironically, men under-performed when they thought the tests would demonstrate their strong mathematical abilities (Brown & Josephs, 1999). Schmader (1999) on the other hand, found the opposing results. Men performed slightly better on mathematical tests when gender interconnection was relevant to the test. The danger of having stereotypes based on gender as they relate to math performance is very real (Spencer et al., 1999) and may explain why we see so few women in engineering. Another study indicated that students did not get involved in class because they were afraid the other students would think they were not smart (Karp & Yoels, 1975). This finding sounds plausible for female students who may worry more about being labeled than male students.

A study by Severiens & Ten Dam, (1997) looking directly at learning styles and its relation to gender interconnection indicated that gender interconnection may be more reliable in understanding gender-related processes in learning than gender alone. Gender interconnection explained more variance than gender in two of the four learning styles (Indicator of Learning Styles or ILS) and an equal amount of variance in the other two learning styles. Women used learning style strategies such as memorizing and rehearsing more than men. Women also understood learning to be active taking in of knowledge and they depended on the instructor to organize their learning more than men.

Another study indicated that feminine instructors (using the BEM sex role classification) received a higher rate of student classroom participation than masculine instructors' courses. Sixty-three percent of the feminine participation occurred in classes taught by females while only 37% occurred in male taught classes. What is interesting is that 41% of these feminine participants were males (cross-sexed). Although female students participated more in feminine taught classes, the majority of participation was by masculine male students. This may be attributed to their feelings of superiority to women which leads them to question women's knowledge and authority even as instructors. Or, this may be a factor of feminine instructors' ability to create a warm and nurturing environment, which encourages classroom participation by all students (Lease & Schmeck, 1990).

It is important to remember that societal expectations place different pressures on men and women, which may lead to gender differences in thinking and behavior. Such gender differences seem to be most noticeable on the T-F dichotomy (Myers et al., 1998; Myers & Myers, 1995). Men are usually encouraged to exhibit thinking oriented expressions while women are usually encouraged to exhibit more feeling oriented expressions. On the T-F dichotomy, three-fifths of males prefer the thinking preference while three-fifths of females prefer the feeling preference.

Salter's Theory of Environmental Types

Learning styles tell one part of the story. The classroom environment needs to be considered in order to give the complete picture. According to Salter (2000a), behavioral environments such as classrooms, provide contexts for behaviors. Murray's (1938) work, which was based on Jungian theory helps to explain the meaning of environment. Murray coined the term, *environmental presses* which referred to the agenda of environments. The two types of presses are alpha presses and beta presses. Alpha presses tend to be objective stimuli from the environment, which are perceived by the person and beta presses are interpreted views of the environment by the individual. A basic principle of environmental assessment is that the people in those settings are the most qualified to provide accurate feedback on that environment.

There are four levels of environments, the interpersonal level, the group level, the societal/institutional level and the cultural level. The interpersonal level provides an organizing context for behaviors. An example of an interpersonal level would be a single interaction between a college student and his/her professor. Establishing norms and roles lead to group settings, which provide an organizing context for interpersonal interactions. The societal/institutional level is where differing groups coexist in the same behavioral context. Lastly, the cultural level refers to the larger societies and organizations where people function. An example of such a culture would be workplace cultures, which consist of many different organizations (Salter, 2002).

Extraverted environments consist of energy from people, things, values, rules, etc. Introverted environments allow individuals to control the degrees of stimulation. Such environments tend to be reserved, quiet and respectful of the needs of others. The environmental perceiving process focuses on the components that are organized by the environmental judging process. The environmental judging process focuses on maintaining a predictable level of organization among elements. Sensing environments focuses on elements serving as sources of energy. Such elements are identified by their practical applicability. Intuitive environments require that people go beyond the specifics of the elements and focus on special patterns and meaning among them. Thinking environments are logical and objective which may seem cold and impersonal. Finally, feeling environments are subjective, groups work in harmony, and personal beliefs are at the forefront (Salter, 2000a).

Environment and Education

Salter (2000b) found that the nature of classroom environments, not learning styles was the main factor in distinguishing self-reported fit in good from poor classroom environments. Class size seems to be a critical factor in deterring students from participating (Karp & Yoels, 1975). Such large classes are unable to create a feeling environment where students would feel at ease in sharing their thoughts and ideas. Introverted thinking environments were especially difficult for all women, especially those who were extraverted feeling types. The ISTJ/INTJ classroom profiles accounted for 55% of the poor classroom performance by female students (Barrett, 1989). Such classrooms had limited instructor-to-student and student-to-student interaction; they were lecture based and possessed a lecture seating format; they were highly structured;

students took thorough notes and worked independently and there was a highly competitive atmosphere (Salter). The ENFP/ESFP classroom profiles seemed to have the best outcomes for student learning (Barrett, 1989; Salter). These classrooms were more collaborative; consisted of group seating with students facing one another; the instructor worked with students during class and went at the pace of the students not the syllabus; and these classrooms had hands-on demonstrations (Salter).

The current study extended research from this researcher's masters' study (Persaud, 1999a), which used the MBTI and SETA. During that masters' research, this researcher was concerned with classroom participation (as measured by the Classroom Participation Survey) and its effects on women's learning styles (as measured by the MBTI) and classroom climate (as measured by the SETA). It was found that the feeling type women in feeling type classroom environments had the highest overall mean (59.44) on the Classroom Participation Survey (CPS). This mean indicated the best-fit and most comfortable classroom environment for these women. Thinking women seemed to do well in either feeling or thinking classroom environments. The analysis of variance indicated that the classroom environment was the key explanatory factor of classroom participation. Students' personality type was not a significant factor, nor was the interaction between the personality and the environment.

Four underlying themes were found in the written comments from the qualitative section of the CPS: *Professor, Students, Environment* and *Material.* Based upon what the participants viewed as *discouraging* and *encouraging* participation in their classes, it would be likely to assume that the professor's role in the classroom directly impacted student learning and comfort. Kopp & Farr (2000) agreed with this researcher's previous findings. They found that professors who displayed warm, friendly and informal classroom environments and who were open to divergent views, as well as encouraged questions and comments, had received from their students favorable student evaluations as well as a greater degree of classroom participation.

Students encouraged each other to learn by asking questions of one another and their equal desire to learn and understand the class material. Environments, which were encouraging, tended to be composed of small class sizes, circular seating patterns, and encouraged interaction among the students. Lastly, the students stated on the CPS that it was encouraging for them to learn when the material was challenging and interesting as well as related to real life in a practical sense (Persaud, 1999b).

Due to the provocative and significant findings from the masters' study, this researcher has decided to follow up with the present research. This study will extend that masters' study by looking at gender identity, learning styles, and classroom environment and how they relate to female students' classroom involvement. Classroom participation extended to classroom involvement, which includes more than verbal participation in the classroom in order to account for the fact that the nature of these classes does not foster much student participation.

Classroom Participation

Classroom participation has been found to be associated with emotional adjustment, self-esteem and intellectual functioning. Students who tend to be active participants in the classroom tend to have higher levels of self-esteem and achievement while those who are passive tend to have higher levels of insecurity. Passive students may benefit when classroom participation seem less intimidating and threatening (Williams, 1971). A challenge to educators would be to help such students feel more comfortable in their environment. For the sciences, this challenge may be especially difficult to meet.

According to Guthrie & Alvermann (1999), meaningful learning occurs when students are engaged or very interested and motivated to learn in their classes. In order to increase student learning, instructors need to develop clear and accurate means of assessing student participation. Students tend to learn more when the rules of classroom involvement, as it relates to the grading policy, are clearly defined (Craven & Hogan, 2001). When students realize that their participation influences their final grades, they adjust their study habits in order to be prepared for active participation in the classroom (Bean & Peterson, 1998).

Student involvement may be interpreted as the amount of time, energy and effort students devote to learning (Craven & Hogan, 2001). Research has demonstrated that the more involved students are in their learning, the higher their levels of persistence in college and continued learning (Bean & Peterson, 1998). Active involvement leads to increased levels of critical thinking, development of listening and speaking skills and the ability to engage in conversations (Bean & Peterson). In other words, students learn more and better when they are actively involved and participate in their classes (Bean & Peterson; Craven & Hogan; Guthrie & Alvermann, 1999).

Today, a good amount of research on the college classroom environment is found; however, research on college classroom involvement exists to a lesser extent. The limited research on classroom involvement has looked at male students' participation, female students' participation, and instructors' teaching styles and indicates that they all come together to create a "chilly atmosphere" for female students (Karp & Yoels, 1975). Female students were found to have less confidence in asking questions during class when compared to their male counterparts. Their minority status in engineering and science classes may explain why they prefer not to be in the spotlight. By being a minority in the class in addition to having low self-confidence, these female students would probably not want to place themselves in such a challenging position (Metz et al., 1999).

Many factors seem to relate to female students' classroom participation (Sandler & Hall, 1982; Sadker & Sadker, 1994; Seymour & Hewitt, 1997). Studies have found that class size does not affect the percentage or number of students who participate in class and that male students participate more than female students even when their proportions were equal (Karp & Yoels, 1975; Lease & Schmeck, 1977). On the contrary, another study indicated that students believed larger class sizes lead to less classroom participation (Lease & Schmeck, 1990). A more recent study indicated professors' interpersonal styles were not directly related to higher student participation rates in the classroom (Fassinger, 1995). Instead, the manner in which professors designed their courses, in addition to the personality traits students brought to the classroom, were the primary factors influencing the classroom participation dynamics. It was therefore concluded that improving students' confidence, creating a positive emotional climate (use of study groups and learning partners), creating a reward system for participation and encouraging student interactions were all examples of how the professor has the power to steer the rate of classroom participation (Fassinger, 1995).

When female students participate, they tend to talk in class to support friends. They feel more comfortable with teachers who do not impose their views on students and they pay more attention to the personal experiences of the students. The openness and supportiveness of the instructor is an important factor in determining whether female students feel comfortable about talking in class (Gabriel & Smithson, 1990). Female students tend to respond more positively to the emotional climate of the class and their participation tends to be related to their confidence (Fassinger, 1995). Male students seem to be more interested in the content of the learning, such as the cognitive and non-personal aspects of the classroom interaction, and tend to make comments or raise questions in class. Moreover, female students attribute the amount and kind of class discussion to teacher's behavior; male students tend to attribute their interests to ideas.

Another study suggested that, for women to participate successfully and be heard in class, they need to behave as their male counterparts (Guinier, Fine, Balin, Bartow, & Stachel, 1994). Such behaviors include participation in arguments, assertively stating their opinions, challenging their faculty and peers with confidence and being comfortable approaching faculty outside of class. The problem is that most women do not see themselves in this manner as learners, therefore, it is a challenge for them to concede to this style of learning.

Summary

The gender differential treatment women face in the classroom is destructive to their self-confidence and their accomplishments (Rowe, 1977). Co-educational campuses and classrooms are “chillier” than single sex schools or classrooms where female students tend to have better educational and career outcomes. Women are still the minority in male-dominated careers such as engineering, technology, and certain sciences. Jung's theory of psychological types may be useful in explaining some male and female dominated fields by understanding the dynamic of the thinking-feeling dimension. Male-dominated fields tend to require more thinking skills which may serve to partly explain the abundance of men in engineering, technology and certain science fields.

The present study was designed to help answer some significant questions related to the recruitment, enrollment and retention of female engineering students. Findings should provide information about the variables that influence women’s academic success, such as the classroom climate as measured by the Salter Environmental Type Assessment (SETA), their learning styles, as measured by the Myers-Briggs Type Indicator (MBTI) and their level of gender interconnection as measured by the Gender Interconnection Scale (GIS). The Classroom Involvement Scale (CIS) was used to gather data on their level of classroom involvement and how it was affected by the three independent variables.

Research Questions

- What influence do learning style, gender identity, and classroom environment have on women's self-reported involvement in engineering classes?

- To what extent is learning style related to gender identity?

CHAPTER 3

METHODOLOGY

Participants

The self-volunteer sample for this study was drawn from a population of 1,061 full-time undergraduate female students from the College of Engineering at the University Park campus of The Pennsylvania State University. The sample consisted of 18.7% of the total full-time undergraduate female students from the College of Engineering. Penn State's main campus is located in central Pennsylvania. In the 2001 fall semester, 1,002 male and 219 female first-year students enrolled into the College of Engineering at the University Park campus. One year later, 836 (83%) men and 176 (80%) women were retained (College of Engineering Retention Study, 2002). As of fall 2002, in the College of Engineering, the minority women breakdown was as follows: Asian American – 89 (8.4%); African American –44 (4.1%); Hispanic/Latina –36 (3.4%); and Native American –2 (0.2%). European-Americans composed 83.9% of the students. Of the original 150 total participants, four were dropped from the study due to incomplete survey forms being returned. Of the total population of 1,061 female undergraduate engineers, 146 or 13.8% participated in this study. The mean age for this sample was 19.93, ranging from 17-27 years of age.

Procedures

Female students in the College of Engineering were invited by the Women in Engineering Program (WEP) personnel to attend one of two data collection sessions conducted in October 2002. Participants included female students from all disciplines in the College of Engineering ranging in levels from first year students to seniors. The data collection sessions took place six weeks after the first day of classes, which allowed first year students to be included in the study.

Participants were initially recruited via an e-mail from the Director of the Women in Engineering Program to female engineering students (Appendix A). This invitation, which explained the purpose of the study and the importance of each woman's participation, was sent a week before and again a day before the data collection session. Students were asked to send the researcher an RSVP in order for her to know the number of surveys needed. Students arrived to the data session room on one of two consecutive nights. Two different dates were chosen in order to better accommodate the students' busy schedules. After the researcher reviewed detailed instructions, confidentially procedures were explained to the students. Then, each student read and signed an informed consent form (Appendix B). One form was returned to the researcher, and each student kept a copy of the consent form. An hour was allocated for each session although most participants actually took approximately 30 minutes to complete the survey packet. Each participant was assigned a four-digit identification number so names were not needed on any of the surveys for data analysis. First names and last initials were necessary in order to return students' MBTI profiles at a future MBTI workshop however. After returning the students' MBTI profiles, names were no longer connected to students' surveys. The data were then pooled.

Of note, a week after each data collection session, these participants were invited to attend an MBTI workshop focusing on understanding their personality and learning styles. This workshop was co-presented by the researcher and a graduate faculty member who had expertise and experience in administering the MBTI. At this one hour workshop, participants learned of the history and development of the MBTI, how, when, and what the MBTI is used for, and how it related to their education and career. They gained knowledge of how to use their strengths to understand and improve their relationships, means of communication and career experiences.

The researcher implemented the more conservative technique of deleting and treating as missing, the entire survey packet for anyone who did not answer an entire assessment instrument. Male engineering students were not included in this study because this researcher did not want to establish males as the norm upon which to compare women. If men are the norm then it is implied that women are not part of that norm. In other words, women are not "normal". It is not this researcher's intention to declare such a sexist statement.

Instrumentation

Demographic Information Sheet. The Demographic Information Sheet (Appendix C) was used to obtain relevant background information, including race/ethnicity, age, major, class standing, cumulative GPA, and socioeconomic status.

The researcher developed this information sheet solely for the purposes of this study. It was revised from the demographic questionnaire originally used in the researcher's master's study.

Myers-Briggs Type Indicator (MBTI) Form M. The Myers-Briggs Type Indicator Form M (Briggs & Myers, 1998) is the most recent version of this instrument. It consists of 93 items. Omitting items is permitted with the thought that the validity achieved would be higher by reducing uncertain answers. The two types of forced-choice formats include phrase questions and word pairs. Within each dichotomy there is not any "right" or "wrong" answer or choice, just the fact that one response may be "correct" for a person of one type versus a person of a different type (Myers et al., 1998).

The MBTI is a serviceable measure of Jung's theory of psychological type (Hammer, 1996; Myers, McCaulley, Quenk & Hammer 1998). It is one of the most widely researched instruments used to measure learning styles and is frequently used in student affairs practice (Evans, Forney, & Guido-Dibrito, 1998). Myers et al., provide a comprehensive summary of its psychometric properties, which includes an improved classification around the midpoint for respondents and a national sample of adults was used to base the scoring (Myers et al.). This instrument offers 16 profiles (Appendix D) produced from four scales: Extraversion/Introversion or E-I, Sensing/Intuition or S-N, Thinking/Feeling or T-F and Judging/Perceiving or J-P.

A national sample of adults over 18 years of age was collected for Form M. From that sample of approximately 3,000 people, 49% were men, 51% women, 80.3% White, 12.1% Black and 7.6% other racial groups. That sample found slightly more Introverts than Extraverts among men and the opposite for women. For both genders, sensing types was between 71% and 75% and more Judging than Perceiving types were found. More men reported the Thinking and more women reported the Feeling preference (44% of the men and 76% of the women reported the feeling preference) (Myers et al., 1998).

The Salter Environmental Type Assessment (SETA). The SETA-Experimental Form B (Salter, 2000b) was used to assess the classroom environment in this study. The SETA Form B is the seventh version of the instrument (Salter, 2000a). The SETA was designed to operationalize the taxonomy of environmental types and to work in combination with the MBTI instrument to provide a means for researchers to study personality functioning within an interactional paradigm (Salter, 2000a). Salter scaled the SETA to correspond to the MBTI. Therefore, the interpretation of SETA and MBTI values should operate in a similar manner. A forced-choice format is used because it helps to reveal truer responses in forcing respondents to make a choice. Phrase questions and word pairs are used because they reflect Myers' proposition that certain types prefer certain response formats (Myers & Myers, 1998; Salter, 2000a).

Item development of the SETA was derived from theory and behavior. Items derived from theory came from an interactional view of Jung's hypothesis and the environmental type taxonomy. Items derived from behavior were taken from the validity studies and the *MBTI Manual*. An example from the E-I scale of SETA is item number 17: *Communication in this environment relies mainly on: (A) written documents or (B) the spoken word* (Salter, 2000a).

The SETA scale is comprised of four scales of 15 response pairs, in addition to 40 test items for a total of 100 items. Similar to the MBTI instrument, the SETA produces four dichotomous type scores (E-I, S-N, T-F, and J-P), which results in 16 environmental type profiles (Salter, 2000a). Environmetric properties of SETA results include studies on sampling, internal consistency and reliability, as well as construct, concurrent and predictive validity (Salter, 2000a; Salter & Vandiver, 2003). In conducting some validity studies, three secondary measures were utilized: the MBTI Form G, the Work Environmental Scale or WES, and the University Residence Environment Scale (Salter).

Gender Interconnection Scale (GIS). The Gender Interconnection Scale (GIS) (Swim, 2002a), (Appendix E) is a twenty-four-item instrument developed to measure the gender connection of men and women. The first twelve items relate to female gender connection or interconnection and the second twelve items relate to male gender connection or interconnection. The questions for both twelve-item scales were identical with the changing of the noun men/women. The GIS was adapted for gender interconnection or interconnection from the Multidimensional Inventory of Black Identity (Sellers et al., 1997) and the Multidimensional Model of Racial Identity (Sellers et al., 1998) (J. K. Swim, personal communication, September 15, 2002).

Male and female connection measures were constructed by selecting items from identity measures (Branscombe, Owen, & Kobrynowicz, 1993 as cited in Swim 2002b; Phinney, 1992) and altered from their original form (ethnic identity) so they referred to men and women (gender identity). GIS items were adapted from Branscombe's Gender Identification Measure, Bargad & Hyde's Feminist Identity Development Scale (as cited in Swim, 2002b), and Phinney's Multigroup Ethnic Identity Measure (J. K. Swim, personal communication, September 15, 2002). Specifically, items were selected to assess perceived similarity with men/women, a feeling of closeness to men/women, seeking information about men/women, and giving priority to issues regarding men/women. Twenty-four items were chosen to represent these components of interconnection (Swim, 2002b).

On the GIS, Swim (2002b) identifies two interconnection scales. For the male interconnection scale, items included the word “men” and for the female interconnection scale, the items included the word “women”. Separate factor analyses of the items that formed the men and women scales resulted in similar two factor structures (Swim). One factor measured similarity (e.g., "I think I have much in common with men/women") and closeness (e.g., "I feel an attachment to men/women as a group"), which were labeled as a measure of similarity/closeness. The second factor measured information seeking (e.g., "I seek out information about men’s/women’s culture”) and prioritizing group issues (e.g., "I am very concerned about the problems men/women have in today's society"), which was labeled as a measure of giving priority to male/female concerns (Swim, 2002a).

Based upon a combination of factor analyses and consideration of the theoretical constructs, 14 items that loaded similarly for men and women were selected (Swim, 2002b). In addition to those 14 items for each of the basic scales, 12 items were included that measured additional components of men’s interconnection. These were items that could only be completed by a person who was a member of the social group (e.g. Male participants could not credibly evaluate the item "I’m proud to be a woman," therefore only the item “I’m proud to be Male” was included) (Swim). This researcher has corresponded with the developer of the GIS and was informed that validity and reliability indices were being developed and not available at the time of this project (J. K. Swim, personal communication, September 15, 2002).

Classroom Involvement Survey (CIS). The CIS is a revised version of the Classroom Participation Survey (Persaud, 1999b), which was designed to assess the level of college students' participation in classroom environments (Appendix F). The CIS focused on student behaviors pertaining to involvement, which included more than student participation. Examples of CIS items include, *I was an active participant in class discussions; I contributed ideas in class;* and *My assertiveness assisted me in participating in class.* Research on classroom participation (Dillon, 1982; Karp & Yoels, 1975; Lease & Schmeck, 1990) helped to generate a set of 18 Likert-type items, which were scaled from "strongly disagree" = -2, "disagree" = -1, "neutral" = 0, "agree" = 1 and "strongly agree" = 2 and NA = not applicable. This scale was also recoded from –2 to 2 to a positive number scale of 1-6 for purposes of ease in data analysis and interpretation. To obtain a fuller view of situational dynamics, the CIS also included three open-ended environmental referents: (a) what should *start* happening in this course? (b) What should *stop* happening in this course? and (c) What should *continue* happening in this course? However, these were not analyzed in this study.

Data Analyses

The Statistical Package for the Social Sciences version 11 (SPSS 11.0) was used for analyzing the data. Frequency distributions, means and percentages represented the descriptive statistics while multiple regression analysis was the inferential statistic used. Multiple regression involves one dependent variable and two or more independent variables. It may be used for prediction with a focus on the dependent variable or explanation with a focus on the independent variables' influence on the dependent variable (Huck, 2000). Stepwise regression analysis was used to determine whether the independent variables, learning style, classroom environment and gender interconnection explained a significant amount of variance in the dependent variable, students' level of classroom involvement. The linearity assumption for multiple regression was examined using curve estimation procedures.

Reason for Implementing Inferential Statistics

Often times, the researcher's primary objective is to draw conclusions based on sample data to the larger population. These conclusions or statements, which are designed to extend beyond the sample is referred to as "educated guesses" or statistical inferences. Inferential statistics refer to statistics that include principles and techniques, which allow researchers to make such generalizations about their findings. For a number of practical reasons, measurement of the entire population is not feasible. Two major reasons included the high cost for the researcher and time to measure an entire population. Another reason is when the population is not available, for example when predictions need to be made based on the current sample (Huck, 2000).

After examining residual scatter plots and using curve estimation procedures, the researcher determined assumptions of normality, linearity, and homoscedasticity between the predicted dependent variable scores and errors of prediction were met. Residuals or differences between obtained and predicted dependent variable scores were normally distributed around the predicted dependent variable scores, the residuals had a straightline relationship with predicted dependent variable scores, and the variance of the residuals around the predicted dependent variable scores was similar for all predicted scores (Tabachnick & Fidell, 2001).

Hypotheses

Based on previous research, two hypotheses were stated regarding this study:

HO^{1} There would not be an association between learning styles, gender interconnection and classroom environment, which would influence the level of women's classroom involvement.

HO^{2} Learning styles would not be related to gender identity, where feeling women would not be more or less likely to identify with men or with women.

CHAPTER 4

RESULTS

The primary purpose of this study was to examine the influence of learning style, gender identity, and classroom environment on women's self-reported involvement in engineering classes. The secondary purpose was to determine whether learning style was related to gender identity. The study included four instruments: the Myers-Briggs Type Indicator (Briggs & Myers, 1998), the Salter Environmental Type Assessment (Salter, 2000a), the Gender Interconnection Scale (Swim 2002) and the Classroom Involvement Scale. The participants were female undergraduate engineering students, representative of all 13 engineering majors. A total of 150 surveys were administered with a response rate of 97.3% (146 participants completed all instruments). Of the total women in engineering (1,061) 146 participants or 13% is a satisfactory response rate for the inferential statistical methods implemented for data analysis.

Age, Ethnicity & Annual Family Income

All 146 participants answered demographic items relating to age, ethnicity and annual family income (Table 4.1). Study participants (*n* = 146) ranged in age from 17-27 and represented different cultural and ethic backgrounds. Of the 146 participants, the minority breakdown is as follows: Asian American – 14 (9.6%); African American –15

Table 4.1

Ethnicity & Annual Income of Participants

Variable	n	Valid Percent
Ethnicity		
American Indian/Alaskan Native	1	.7
Black/African American	15	10.3
Asian-Pacific American	14	9.6
Hispanic American or Puerto Rican	7	4.8
White American	98	67
Foreign National	8	5.5
Other	1	.7
Multiple	2	1.4
Annual Income		
Less then $8,000 per year	2	1.4
$8,001-$18,000 per year	8	5.8
$18,001-$28,000 per year	12	8.6
$28,001 - $40,000 per year	14	10.1
$40,001 - $55,000 per year	19	13.7
Over $55,000 per year	84	60.4

(10.3%); Hispanic/Latina –7 (4.8%); Native American –1 (0.7%); and International Students - 7 (4.8%) with 98 (67%) White/Caucasian women. Of the 16.1% underrepresented minority women in the College of Engineering, 25.4% of the study sample represented underrepresented minority women students. Of the 146 participants, 139 (95.2%) answered the demographic item, estimated family annual income (Table 4.1). The majority of participants (60.4%) reported annual family incomes over $55,000 per year.

First-Generation College Students and Relative(s) Earned College Degree

All 146 participants answered demographic items relating to first-generation college students and relative(s) earned college degree. Twenty-nine (19.9%) participants were first-generation college students. One hundred and seventeen (80.1%) participants were not first-generation college students. Ninety (61.6%) participants had a relative who earned a college degree. Fifty-six (38.4%) participants did not have a relative who had earned a college degree.

Class Standing and Sex of Instructor

Of the 146 participants, 143 (97.9%) answered the demographic item relating to class standing (Table 4.2). Participants were distributed evenly among the first through fifth year. The question asking participants to report the sex of instructor for the course assigned to rate for this study reported the following. Female instructors taught 30 (20.5%) while male instructors taught 114 (79.5%) of these courses.

Majors

All 146 participants reported their choice of major, and all thirteen engineering majors were represented with various combinations included in the sample (Table 4.2). The majority of participants were in chemical, electrical, industrial, mechanical and architectural engineering.

Most of the participants were distributed among the chemical engineering, electrical engineering, industrial engineering, architectural engineering and mechanical engineering majors. Twenty-three (15.8%) women were chemical engineering majors. Twenty (13.7%) women were electrical engineering majors. Sixteen women (11.0%) were industrial engineering majors. Fifteen (10.3%) women were architectural majors and 15 women were mechanical engineering majors. Fifteen (10.3%) women were mechanical engineering majors. These five majors together accounted for 61% of the participants' engineering majors.

Table 4.2

Class Standing, Sex of Instructor(s), & Majors of the Study Participants (n=146)

Variable	n	Valid Percent
Class Standing		
First Year	34	23.8
Second Year	29	20.3
Third Year	34	23.8
Fourth Year	25	17.5
Fifth Year	21	14.7
Sex Of Instructor(s)		
Male	114	79.5
Female	30	20.5
Both	2	1.4
Majors		
Architectural	15	10.3
Aerospace	6	4.1
Agricultural	1	.7
Agricultural & Biological	1	.7
Bioengineering	8	5.5
Civil & Environmental	6	4.1
Chemical	23	15.8
Computer	8	5.5
Computer & Electrical	1	.7
Computer Science	7	4.8
Electrical	20	13.7
Electrical & Biological	1	.7
Engineering Science	12	8.2
Industrial Engineering	16	11.0
Mechanical	15	10.3
Nuclear	2	1.4
Nuclear & Mechanical	1	.7
Undecided	3	2.1

Cumulative Grade Point Average

Of the 146 participants, 116 (79.4%) answered a demographic item relating to cumulative grade point average (GPA) (Table 4.2). It is this researcher's impression that the rest of the students did not answer this question because they may not have felt comfortable sharing such personal information even though they were informed of their ensured confidentiality. The mean G. P. A. was 3.25, ranging from 2.1-4.0 with a standard deviation of .447. The population of female students from the College of Engineering is primarily White Americans, between the ages of 18-22 years old, ranging in G. P. A. from 2.75-4.0 in their 3^{rd}-9^{th} semester, and range from architectural, chemical, civil, electrical and mechanical engineering majors.

Summary Statistics for Variables in Regression Analysis

One of the purposes of this study was to examine the relationships between learning style, classroom environment, and gender interconnection on the level of women's classroom involvement within core engineering courses. The means and standard deviations for each of the 11 scales used are provided in Table 4.3. The mean score was 61.19 for the Classroom Involvement Scale (CIS), ranged from a low of 27 to a high of 86. The mean score of 61.19 suggested that female engineering students "agreed" or "strongly agreed" with most of the CIS statements. Based on the alpha coefficients, the scores seem acceptable and trustworthy for further analysis. Table 4.4 provides a

Table 4.3

Descriptive Summary Statistics and Reliability Estimates for Variables Used in the Regression Analysis (n=146)

			Actual Range		
Scale	Mean	S. D.	Low	High	Cronbach's α
CIS	61.192	13.36	27	86	.874
MBTI EI	-1.71	11.66	-21	21	.899
MBTI SN	.18	12.72	-24	26	.868
MBTI TF	.05	11.97	-24	22	.880
MBTI JP	-2.48	12.38	-22	22	.918
SETA EI	-.78	7.79	-15	15	.777
SETA SN	-6.10	6.81	-15	13	.793
SETA TF	-5.90	7.12	-15	15	.844
SETA JP	-4.99	6.39	-15	15	.767
GIS Female	4.2174	.979	1.17	6.58	.835
GIS Male	3.6052	.795	1.33	5.92	.778

Table 4.4

Correlation table MBTI, SETA, GIS, and CIS scores (n=146)

	CIS Total	MBTI EI	MBTI SN	MBTI TF	MBTI JP	SETA EI	SETA SN	SETA TF	SETA JP	GIS female	GIS male
CIS											
MBTI EI	**-.239**										
MBTI SN	**.175**	-.129									
MBTI TF	.086	.105	**.248**								
MBTI JP	-.043	.011	**.399**	**.272**							
SETA EI	**-.569**	**.147**	-.124	.063	.029						
SETA SN	**.461**	-.118	**.184**	.056	.085	**-.632**					
SETA TF	**.632**	**-.176**	.110	.052	-.073	**-.757**	**.766**				
SETA JP	.068	-.058	.023	-.043	-.031	-.116	**.244**	**.175**			
GIS female	.108	-.103	.105	.119	-.076	.007	.019	.084	-.134		
GIS male	**.201**	**-.285**	.021	-.075	-.068	-.082	.086	.029	.041	.085	

Note: Correlations in bold are significant at $p < .05$.

correlation table for these variables. Finally, the Gender Interconnection Scale (GIS) female had a mean score of 4.21, and GIS male had a mean score of 3.60.

Stepwise Regression Analysis

Stepwise multiple regression analysis was used to determine whether learning styles, classroom environment, and gender interconnection explained some degree of variance in the dependent variable, level of student classroom involvement. Table 4.5 shows the fully saturated regression model. This is a significant model (F = 12.29; df = 10, 135; $p < .001$), which accounted for 48% of the variance in the dependent variable, level of student classroom involvement. However, since all of the variables that were entered into the initial regression equation are not significant at the .05 alpha level, a reduced or more parsimonious model was developed. Seven of the 10 variables in the full model were not statistically significant; therefore, the final reduced stepwise model was subsequently implemented. Table 4.6 represents an MBTI and SETA type table for the participants in this study. Table 4.7 shows the final regression model with classroom involvement as the criterion variable.

In the final model, three dimensions were significant variables in explaining variance in the level of classroom involvement. The SETA-TF, GIS Male and SETA-EI dimensions explained 44.8% of the variance as indicated by the R^2 value of .448 (F = 38.40; df = 3, 142; $p < .001$). Although learning styles and gender interconnection were not found to be significant, they did provide an interesting correlation (see Table 4.4).

Table 4.5

Initial Regression Results for the Classroom Involvement Scale (CIS) Regressed on MBTI, SETA and GIS (Fully Saturated Model)

Independent Variable(s)	*b*	*SE b*	ß	Part *r*	Partial *r*	*t*	*p*
MBTI EI	-.092	.077	-.080	-.074	-.102	-1.191	.236
MBTI SN	.094	.075	.090	.079	.108	1.261	.209
MBTI TF	.092	.076	.082	.075	.103	1.208	.229
MBTI JP	-.038	.078	-.036	-.031	-.042	-.493	.623
SETA EI	-.371	.169	-.216	-.137	-.185	-2.192	.030
SETA SN	-.211	.202	-.107	-.065	-.089	-1.042	.299
SETA TF	.973	.229	.519	.264	.343	4.239	.000
SETA JP	-.062	.136	-.030	-.028	-.039	-.455	.650
GIS female	.285	.891	.021	.020	.027	.320	.750
GIS male	2.611	1.110	.156	.147	.199	2.353	.020
Constant.	54.164	5.439				9.959	.000

F = 12.286 Multiple R^2 = .690
df = 10, 135 R^2= .476
p = <.001 Adj. R^2= .438

Table 4.6

MBTI and SETA Type tables (n=146)

Scale	MBTI		SETA	
	Frequency	Percent	Frequency	Percent
E	88	60.3	65	44.5
I	58	39.7	81	55.5
S	64	43.8	119	81.5
N	82	56.2	27	18.5
T	63	43.2	117	80.1
F	83	56.8	29	19.9
J	83	56.8	119	81.5
P	63	43.2	27	18.5

Table 4.7

Reduced Regression Model Results for Classroom Involvement Scale (CIS) Regressed on the Salter Environmental Type Assessment TF & EI, and the Gender Identity Scale (Male)

Independent Variables	*b*	*SE b*	ß	Part *r*	Partial *r*	R^2 Change %	*t*	*p*
SETA TF	0.909	0.179	.485	.316	.392	40.0%	5.071	.000
GIS Total Male	2.876	1.052	.171	.171	.224	3.3%	2.735	.007
SETA EI	0- .322	0.164	-.188	-.122	-.163	0.3%	-1.964	.051
Constant	55.94	3.988					10.316	.000

Summary Information for the final regression model:

$F = 38.40$	Multiple $R^2 = .669$
$df = 3,142$	$R^2 = .448$
$p = <.001$	Adj. $R^2 = .436$

The regression results indicate that higher SETA-TF values were associated with higher perceived classroom involvement values (partial $r = .392$). The SETA-TF variable explained 40% of the variance in the dependent variable, classroom involvement. The regression results indicate that higher GIS male values were associated with higher perceived classroom involvement values (partial $r = .224$). The GIS variable explained 3.3% of the variance in the dependent. The regression results indicate that as SETA–EI values increased, classroom environment scores decreased (partial $r = -.163$). In other words, the more introverted classrooms had less classroom participation from students. The SETA-EI variable, which approached significance ($p = .051$, Huck, 2000) explained .3% of the variance in the dependent variable, classroom involvement.

CHAPTER 5

DISCUSSION AND CONCLUSIONS

Need for the Study

A milestone for women in higher education came with the passage of Title IX in 1972 (The Chronicle of Higher Education, 2002). Female graduate and undergraduate students have made great strides in access to higher education. Although today, women attend college in greater numbers than men, they are still underrepresented in disciplines such as science, mathematics and engineering (Orenstein, 1994; Swim & Stagnor, 1998b; The Chronicle of Higher Education, 2002). This study addresses how undergraduate female students' learning styles, classroom environment and gender interconnection influence their degree of classroom involvement in core engineering courses.

The U. S. workforce continues to be almost entirely segregated by gender. Many occupations are either predominantly male or female (Ehrhart & Sandler, 1987; Sadker, 2000). Although more women are found in service jobs, labeled the "pink collar ghetto" (retail sales, clerical, etc.), more men are found in higher paying, more prestigious jobs in such fields as medicine, law, computer science, mathematics and engineering. Science and technology continually change the way people live. With a shortage of women with expertise in these areas, society loses their valuable perspectives in our technological future (Ehrhart & Sandler). By not using women's talents, society loses their great contributions.

Societal biases based on gender combined with gender differences in mathematical confidence create this attrition mechanism resulting in gender-dominated fields. Male dominated fields such as engineering, technology, mathematics, computer science, natural science, health diagnosing occupations, executive, administrative and managerial positions (Barber, 1995; Murray et al., 1999) do not foster positive working and learning environments for women (McGeveran, 2002; Meggett, 1997). This may be the reason for the lack of women in science and engineering careers.

Understanding why women remain underrepresented in science, mathematics and engineering majors may at first glance appear puzzling. Starting before ninth grade, both girls and boys seem identical in their academic performance in math and science courses. Yet, a big plunge in mathematical interests begins in high school that is still evident in college. The further they get in their education, girls take fewer math and science based courses. While they tend to have higher predicted college grade point average (G. P. A.) scores when compared to their male peers (i.e., 3.05 versus 2.99 in engineering) (Seymour & Hewitt, 1997), women still do not persist in their math, science and engineering majors at the rates of men. By the time they reach college, the ratio of men to women intending to major in engineering in college is five to six men to every one woman (Seymour & Hewitt, 1997).

Research focusing on the factors contributing to this pattern of female attrition from science and engineering is critical. The "personal is political" because how individual female engineering students are treated in the classroom directly impacts their minority status in the field of engineering. A career as an engineer brings an elevated status in terms of prestige, wealth and power. Discouraging women from these fields keeps them from attaining such a position that can improve their overall status within society. Attending college in higher numbers is not equivalent to achieving gender equity in higher education when people take a closer look at the fields women are studying. Women are over-represented in education and liberal arts careers and severely underrepresented in technology and engineering careers. For society's benefit, it would seem critical that methods are designed to resolve the current status of women in engineering.

Gender equity needs to be systematically implemented with the support of all faculty members in order for equity within higher education to succeed. We need committed faculty and staff who are devoted to teaching and student learning. The educational programming needs to be packaged concisely where the time commitment to learn and teach these concepts will not overwhelm already busy faculty. Finally, gender equity needs to be prioritized and given a spotlight at educational and professional meetings, journal publications and conferences. These issues need to be addressed in the education of all teachers (Sanders, 2002).

Statement of the Problem

In general, a chilly institutional climate for women results in lower reported gains in academic success when compared to women who do not perceive a chilly institutional climate (Sander & Hall, 1999). As expected, the longer women remain in such chilly environments, the more damaging the effects upon their educational gains (Whitt et al., 1999). Although women prefer classroom interaction, writing papers and having peer discussion, they are forced to adapt to the historic teaching styles of male faculty, which tend to be more introverted, lecture-based classrooms (Ferguson, 1992).

The purposes of this study are to identify the factors that may contribute to the attrition of female students in engineering and to make concrete recommendations in order to improve their enrollment and retention rates. Three major elements, which have been identified in creating the “chilly classroom climate”, are student-instructor interactions, female faculty representation, and the academic curriculum (Hall & Sandler, 1982; Sandler, Silverberg, & Hall, 1999). In this dissertation, the focus is on student-instructor interactions, because this area seems to have the strongest influence on women’s learning outcomes within the classroom and is the area in which intervention can be most effective (Chapman, 1989; Cranston, 1989; Hall & Sandler; Sandler, Silverberg, & Hall, 1999; Prentice, 2000; Sadker & Sadker, 1994; Williams, 1971). Specifically, I focused on how learning styles, classroom environment and gender interconnection of the female students influence their level of classroom involvement.

Sample and Design

The volunteer sample for this study came from a population of 1,061 (18.7% of total population of male and female engineering majors) full-time undergraduate female students from the College of Engineering at the University Park Campus of The Pennsylvania State University (Penn State). Study participants were 146 or 13% of the total population of women undergraduate engineering majors, ranging in age from 17-27 and represented different cultural and ethic backgrounds. Of the 146 participants, the minority breakdown was as follows: Asian American – 14 (9.6%); African American –15 (10.3%); Hispanic/Latina –7 (4.8%); Native American –1 (0.7%); and Foreign National 7 (4.8%) with 98 (67%) White/Caucasian women.

Participants were initially recruited via an e-mail invitation from the Director of the Women in Engineering Program sent to female engineering students. This invitation, which explained the purpose of the study and the importance of each woman's participation, was sent one week before and again a day before the data collection session. The data collection sessions took place six weeks after the first day of classes, which allowed first year students to be included in the study. One week after the data were collected, participants were invited to a Myers-Briggs Type Indicator workshop in order to receive their MBTI profiles and an interpretation of their learning style.

Instrumentation

A Demographic Information Sheet was used to obtain relevant background information, including race/ethnicity, age, major, class standing, cumulative GPA, and socioeconomic status. Based on Jung's (1971) theory of psychological types, the Myers-Briggs Type Indicator Form M (Myers, 1998) was used as a measure of learning styles. The SETA-Experimental Form B (Salter, 2000a) was used to assess classroom environment. The SETA was designed to operationalize the taxonomy of environmental types and to work in combination with the MBTI instrument to provide a means for researchers to study personality functioning within an interactional paradigm.

The Gender Interconnection Scale (GIS) (Swim, 2002a), was used to measure gender interconnection (J. K. Swim, personal communication, April 14, 2003). The GIS is a twenty-four-item instrument developed to measure the gender connection of men and women. The Classroom Involvement Survey (CIS) is a revised version of the Classroom Participation Survey, which was designed to assess the level of college students' participation in classroom environments. The CIS focused on student behaviors pertaining to involvement, which included more than students' verbal participation.

Data Analysis

SPSS 11 was used for analyzing the data. In the present study, stepwise-multiple regression analysis was implemented with a focus on explanation of the independent variables (learning styles, classroom environment, and gender identity) influence on the dependent variable (students' level of self-reported classroom involvement). Stepwise multiple regression analysis was used to determine the extent to which the independent variables explained variance in the dependent variable (Huck, 2000). Since all of the variables that were entered into the initial regression equation are not significant at the .05 alpha level, a reduced or more parsimonious model was developed. Seven of the 10 variables in the full model were not statistically significant; therefore, the final reduced stepwise model was subsequently implemented (see Table 4.7).

Research Question Relating to HO[1]

What is the association between learning styles, gender identity, and classroom environment which influences women's self-reported involvement in engineering classes? It was hypothesized that collectively, learning styles, gender interconnection and classroom environment would influence the level of women's classroom involvement. Only three dimensions were significant variables in explaining variance in the level of classroom involvement. The SETA-TF, SETA-EI, and Gender Interconnection Scale - Male dimensions explained about 45% of the variance as indicated by the R^2 value of .448 ($F = 38.40$; $p < .001$) (see Table 4.5).

The results indicate that higher SETA-TF values are associated with higher perceived classroom involvement values (partial r =. 392) (see Table 4.5). In other words, the feeling classroom environments were associated with higher degrees of classroom involvement from female students compared to the thinking classroom environments. This finding makes sense since it is easy to imagine that the feeling oriented classrooms, especially the extraverted ones, are more open to student participation (Barrett, 1989). Instructors who create such an environment want students to feel comfortable in sharing their ideas, opinions, comments and questions so they design techniques to draw in such student involvement. Students tend to feel good about being involved in these classes because they are not ridiculed or humiliated when they are incorrect. Instead, their instructors and classmates appreciate and respect their contributions. Also, such classes are not the traditional stereotypical engineering classes where the instructor lectures and the students rush to take steady, detailed notes. Such environments leave little or no time for students' questions and instructors' feedback. First Year Seminars are examples of courses which were included in the core engineering course requirements which tend to be smaller in size and more open to student involvement (Persaud, 1999a).

The regression results indicate that as SETA–EI values increased, indicating introversion, classroom involvement values decreased. For SETA-EI, the relationship with classroom involvement was negative (partial r = -.163). Not surprisingly, the extraverted classrooms were found to approach significance (at the p = .051 level) in relation to classroom involvement. In other words, the introverted classrooms had lower levels of classroom involvement when compared to the extraverted classrooms. This finding is consistent with Barrett's (1989) finding. There were not many extraverted engineering classrooms. In this study however, participants rated the core engineering classrooms as mainly introverted (70%). However, this finding is important and may be explained by the fact that some instructors may choose to create such an environment even in mathematically oriented engineering courses.

Of the 146 female participants in this study, 88 were extraverts (60.3%) while 58 (39.7%) were introverts (see Table 4.5). This finding agrees with the percentage of women who are extraverts (63%) and introverts (37%) in the population (Jensen, 1987). It is surprising that the MBTI-EI dimension was not significant (p = .236) (see Table 4.4). According to Jensen (1987) extraverts tend to talk as they think which may lead to higher classroom involvement indices. The extraverted students would be more likely to be involved in both the introverted and extraverted classrooms. However, results from this study do not coincide with Jensen's findings. Engineering classrooms seem to be primarily INTJ environments where the fast-paced nature of the discipline does not encourage student involvement. Involvement refers to brief, concise answers to questions and students are penalized for anything beyond. Since women are a minority in engineering classrooms, regardless of their extraversion, their status as minorities in the classroom may contribute to their low levels of classroom involvement.

This finding is similar with the findings of Kramer-Koehler, Tooney & Beke (1995), which indicated that female students are more likely to be extraverts than introverts. According to Rosati (1993), introverted students tend to be more successful in engineering than extraverted students. This finding leads to the provocative assumption that classroom involvement may not be necessary for success in the engineering discipline. Results from this study did not support nor reject Rosati's findings. It is possible that introverted students may have an easier time coping in an introverted classroom environment since it matches their learning style preference. However, introverted students may also be more at risk in such an environment since they are less likely than extraverted students to seek assistance inside or outside of class when needed.

Lastly, women who interconnected with males tended to have higher levels of classroom involvement when compared to women who interconnected with other females. One explanation of this result could be that such women see themselves as different from other women and more similar to men. In this case, these women are likely to identify with certain stereotypical male characteristics such as assertion the classroom.

Male students tend to be more assertive and care less about how they are perceived than female students (Valian, 2000). Such qualities are valuable in a field that is so competitive. Therefore, female students who are assertive and self-reliant may be more respected by their male peers and instructors, explaining why they remain in their engineering majors. These women, being more assertive than females who identified or interconnected with women, may make more eye contact with instructors, volunteer to answer or ask questions rather than passively wait to be called upon, and may be less afraid of what others think of them. Societal gender roles teach women to be feminine. According to Valian, feminine women are seen as less competent. This finding implies that women who want to be taken seriously for their abilities may adopt characteristics typically exhibited by males or connect to the gender interconnection labeled as male with the objective of being successful. If this phenomenon is allowed to continue, the engineering field and culture will lose its diversity by including only those who think and behave in a male-oriented fashion. Do women need to adopt male characteristics in order to succeed in engineering or the does the engineering culture need to accommodate to women's strengths? This is a very interesting and provocative question that still remains extremely controversial.

<u>Research Question Relating to HO^2</u>

To what extent is learning style related to gender identity? In this study, I hypothesized that learning style would be related to gender identity, where feeling women would have a preference in identifying with the female gender interconnection than with the male gender interconnection. The findings of this study suggest that learning style was not significantly related to gender interconnection (male $r = -.075$, $p = .186$; female $r = .119$, $p = .076$). This result was not congruent to the findings of Rosati's (1993) study, where successful female engineering students tended to be the SFJ (sensing-feeling-judging) types, and those with the feeling preference performed equally to males who possessed the thinking preference. Since learning styles were not a significant finding in the regression analysis, Rosati's findings could not be substantiated by findings in the current study.

Implications of this Study

Understanding female students' preferred learning environment leads to several recommendations in how to teach towards their strengths. Active classroom involvement increases student learning. In other words, students learn more when they interact with each other and with the instructor (Bean & Peterson, 1998; Craven & Hogan, 2001; Guthrie & Alvermann, 1999). If we believe that active student involvement in the classroom leads to increased learning, then it is clear that we need to strive to create more extraverted classrooms. Based upon the findings of this study, it is the extraverted-feeling classrooms that predict higher levels of student classroom involvement. Therefore, it may be beneficial to increase the amount of hands-on, experiential learning in addition to increased opportunities for teamwork (extraverted and feeling environments), which would assist engineering students in their overall learning (Kramer-Koehler et al., 1995; Rosati, 1993).

The major finding of this study was that feeling classroom environments were associated with higher degrees of classroom involvement from female students compared to the thinking classroom environments. Based on this finding, and consistent with previous research (Salter & Persaud, 2001), it is obvious that such feeling oriented classroom environments have more positive learning outcomes for female students. Therefore, educators should attempt to create such environments.

Examples of ways to make the classroom more extraverted-feeling oriented would be to encourage communication between instructors and students as well as assist them in relating to each other's position. When they can understand the challenges of being in the other's position, they may be more sympathetic to each other's struggles. Instructors should be encouraged to abstain from humiliating students for asking questions or being wrong in their answers, instead, they could create an open and encouraging environment for student feedback and questions. Lastly, they may offer different sections for challenging courses (e.g. 3-6 credits of Calculus), where students have the option of taking the same course at a different pace. The slower paced course may be more likely to incorporate extraverted-feeling classroom tendencies because there would be less pressure on the instructor to cover an insurmountable amount of material in a limited time. Such an environment would allow the instructor to allocate time for students' questions and comments as well as time for hands-on activities in the classroom.

The traditional roles for instructors are often responsible for inhibiting student participation in the classroom. For example, most instructors create a climate where they dominate classroom discussion, ask factual questions, which require brief answers, and they do not know how to stimulate discussion (Penick & Bonnstetter, 1996). Many instructors do not know how to evaluate students as individuals on group projects; students do not have concrete examples of what constitutes active classroom participation (Good & Brophy, 2000); and instructors do not always have a quantifiable means of measuring participation when it is included in students' final grades.

The findings of the present study imply that extraverted and feeling classroom environments lead to higher levels of female engineering students' classroom involvement. Based on the finding that active classroom involvement improves learning, the goal of educators should then be to create such environments in order to improve learning outcomes for students. Creating a less stressful and more enjoyable learning process may improve the effectiveness in retaining the at-risk students who are more likely to drop out or change their majors. Designing the classroom to be more inclusive and less hostile not only stimulates the curiosity of students but it will increase the pool of qualified students in science and engineering majors. For example, creating smaller class sizes, especially for introductory courses, can accomplish this objective. Such environments are more likely to incorporate extraverted-feeling characteristics due to increased opportunities to interact in a more intimate setting.

A second strategy might be to implement mandatory faculty-student conferences at least once per semester. This strategy would especially help those introverted students to feel more comfortable approaching and communicating with their engineering faculty. A third strategy would be to encourage faculty and students to attend seminars, presentations and social engineering gatherings. This strategy would encourage more communication between students and faculty and reduce students' perception of faculty intimidation by improving the relationships among students and faculty. A fourth strategy would be for colleges to place more emphasis on rewards for effective teaching on faculty's promotion and tenure process in order to give additional incentives for them to strive to design more extraverted feeling classrooms. Instructors could introduce different activities during class such as programming computers; conducting many hands-on lab experiments and facilitating discussions; demonstrating real world applications of theories by using toys and props; and allowing time for writing exercises to get the introverts to demonstrate their knowledge.

Finally, allowing time for questions, comments and dialogue among students and between students and instructor is yet another strategy. Assisting instructors to design classes that allow time for discussion and questions, can be accomplished by teaching instructors how to promote effective discussions in engineering courses and how to encourage student interaction. Time for student interaction will increase student participation which will lead to student overall learning.

It is important to understand what exactly is responsible for female engineering students who exhibit characteristics typically exhibited by males for their higher levels of involvement in the classroom. Based upon this study's findings, it appears to be advantageous for female engineering students to be interconnected to men. Such a connection to characteristics typically exhibited by male students seems to improve the level of student classroom involvement, thus increasing their overall learning. Decisions will need to be made on whether this is a characteristic that should be taught to all female engineering students or whether the engineering culture needs to accommodate to the strengths of female students (Barber, 1995). A combination of both strategies is probably most productive for women engineering students.

It is not clear why these findings did not show significance on the MBTI learning styles preference of students. On a positive note, if learning styles do not affect classroom involvement to the extent that classroom environment does, then it becomes clear what needs to be done to generate modifications within the classroom. Making changes to the classroom environment so that it encourages students to be active participants appears to be a much easier task than teaching to all 16 learning styles or teaching students to adapt to numerous teaching styles. Educational workshops on how to create extraverted-feeling classroom environments could easily teach instructors how to incorporate their teaching styles to create such classroom environments for their students. As a result, all students should show learning increases and educational gains.

Limitations

The researcher recognizes several limitations to this study. First, the sample size of 146 out of a total of 1,061 women engineering students was only 13.8% of the total population. External validity or generalizability of the study was not assured for women students who did not participate in this study or women engineering students at other universities, although this study appears to replicate earlier findings using similar methodology (Salter, 2000b; Salter, 2003; Persaud & Salter, in press). Using non-self-reported classroom performance indicators may reveal different classroom dynamics (Persaud & Salter). Primary data were not collected on the instructors who may play an important role in understanding significant aspects of the classroom dynamics (Persaud, 1999a).

The women who volunteered to participate in this study represented a select group of students who felt it was important to be a part of this study. Whether they felt responsible for sharing their experiences or curious about their learning styles was not clear. As in all voluntary study participants, those who choose to participate may be different from those who choose not to participate. Furthermore, even the homogeneous sample consisting of only female participants may not tell the entire story for undergraduate engineering students' learning environment. The experience of male students may provide a valuable and critical insight into understanding what takes place within the engineering classrooms and may shed more light on all three of the above constructs.

In terms of class standing, first year students were included because of the fact that student attrition is most likely to occur within the College of Engineering at the end of the first year. The data on these students were believed to be quite valuable in understanding why so many first year women students switch out of engineering so early. The one problem with this group is that the survey packets were administered on the sixth week of the first day of classes. If a first year woman had not currently been taking one of the pre-assigned core engineering courses, then she would not have been able to participate in the study. However, to ensure everyone could be included, the first year seminar, which every bachelor degree seeking student must take at Penn State University, was included in the pre-assigned courses, which avoided all occurrences of this particular problem and gave feedback about a less traditional core-engineering course.

A possible methodological limitation to this finding may be that the feeling oriented classes were primarily First Year Seminars. These seminars are orientation courses for first year students, which more resemble discussion based, relaxed atmospheres that encourages student involvement. In this study, only (19.9%) of the core engineering courses were first year seminars, while the rest of the courses (80.1%) were composed of math and physics. Of the extraverted courses, 17% were First Year Seminars, 11% were Physics 211 Recitation and 70% of the courses were introverted (Math 140, Math 141 and Physics 211 Lecture). Of the feeling courses, 12% were First Year Seminars, and 88% were thinking courses (Math 140, Math 141, and Physics 211 Lecture and Recitation). Interestingly, the goals of the first year seem consistent with the previous findings on ways to improve the classroom.

A final concern related to timing pertained to those students who had taken the assigned core engineering course years prior to the date they were participating in this study. This is an example when accuracy of memory comes into play. These particular participants were asked to complete the survey packet as close to their memory of the course as they could remember. They may not have remembered the course accurately.

Future Research

The present study would be improved by considering techniques to encourage more women to participate in the study. This objective could be achieved by attending their *Society for Women Engineers*, *Women in Science and Engineering* and sorority, *Phi Sigma Rho* meetings to recruit and collect data. An attempt to diversify the sample would be beneficial in capturing the experiences of racial minority students who made up a small percentage of the current study's sample. Another way to increase the sample size may be to obtain the College of Engineering Dean's involvement in support of the study. The Dean could encourage faculty to support the research by offering extra credit to those students who participate. Also, the timeline to collect data could be extended over several consecutive weeks to get the most participants as possible.

More research is needed on students' experiences. Some suggestions include:

- It would be interesting to find out if minority female students have different learning styles and level of classroom involvement from majority female engineering students. Collect and compare data from a Predominantly White Institution to a Historically Black College or University/Hispanic Serving Institution, to compare the learning styles, gender identity, and perception of the classroom environment of majority and minority engineering students.
- Compare a women's college engineering program (e.g. Smith College) to a co-educational college's engineering program. Do faculty members teach differently or treat women students differently? Which type of institution has better outcomes for female students?
- Conduct a qualitative study implementing focus groups to understand what female students think is the reason for their minority status in engineering and what can be done to improve the climate. A great deal can be learned from female engineering students and qualitative studies are the best ways to get their true experiences and suggestions for improving the climate. It is also the most direct way to counter some of the negative effects of the current environment for female students.

- Look at qualitative feedback of female engineering students regarding the engineering classroom environment, which was gathered in this study, and how their interactions with their instructors and male students affect their learning outcomes. This is important in finding out exactly how female students' relationship with male peers and instructors affect their academic achievement and self-confidence. It may lead to some concrete suggestions for making changes that would have a positive outcome for all students.
- Gain a better understanding of why female engineering students who interconnect with males tend to have higher classroom involvement levels than female engineering students who interconnect with females. Research could be conducted in order to find out what exactly leads to this difference in classroom involvement.
- Conduct a study that would examine whether there is a difference in sex of instructor in creating a feeling classroom environment. Some studies indicate that female instructors are more likely than male instructors to create feeling classroom environments. If this is the case, then engineering which mostly consists of male instructors would need to focus on teaching their male instructors how to create such feeling environments.
- Conduct a longitudinal study of first year female engineering students and how they perform throughout their college career. What leads to their attrition and when are they most likely to drop out of the college? It is important to understand and be aware of the major factors which lead to these students' success and failure. Such an understanding would assist in retention efforts.

- Look at men and women in math, science and technology fields and compare them to students in education, liberal arts and communication fields. What specifically accounts for the greater number of female students in the latter categories (classroom environment versus learning styles)?
- Look at graduate engineering students' success rates and compare learning styles and gender interconnection of males to females.
- Include male engineering students to get the entire picture of what is going on in the classrooms. Do they experience similar benefits of the extraverted-feeling classroom environment? Give male engineering students the Gender Interconnection Scale to find out if those who identify with the male gender interconnection have higher classroom involvement indices and those who identify with the female gender interconnection have lower classroom involvement indices.

Conclusion

The "leaky pipeline" needs immediate repair because we lose women before they ever contemplate engineering as a major. We lose the majority of them during their first year in their engineering disciplines and this attrition results in a diminutive group who complete their Bachelor of Science degrees in engineering who may then pursue graduate programs in engineering (Blaisdell, 1995).

This study has added to the body of research that has investigated female students' minority status in engineering. This study was unique because it combined the use of learning styles, gender interconnection and classroom environment in its search to understand female students' level of self-reported classroom involvement. Even though engineering classrooms tended to be introverted-thinking environments in this study, extraverted-feeling environments seemed to have more positive benefits for female students. The EF combination of classroom environments tends to have higher levels of female student classroom involvement. Understanding that students learn more when they are actively involved in the classroom (Bean & Peterson, 1998; Craven & Hogan, 2001) leads to the clear objective of creating extraverted-feeling classroom environments in all disciplines.

Another major finding of this study indicated that female students who possessed higher levels of connection and interest in male issues and concerns tend to have higher classroom involvement indices than women who possessed lower levels of connection in these areas. Although more research in this area is necessary to make more concrete conclusions, it may be worth discussing whether it would benefit female engineering students in the short term, to understand the advantages of adapting to such areas.

Based on this study's findings, it is the responsibility of higher education administrators to assist the faculty in understanding how they can design their classroom environments to be more feeling and extraverted in order to increase student involvement and overall learning. Such change in classroom environments may result in greater recruitment, enrollment, retention and graduation rates of female engineering students and possibly of male engineering students. It is to the benefit of the College of Engineering to invest the time, energy and financial resources to find out if the extraverted-feeling classroom environment would benefit engineering students. This study gives direction to making a long needed change.

In assessing students' participation, instructors could evaluate active participation in discussion; contribution of relevant resources to the class; preparedness to class; acceptance of course requirements and constructive feedback and making contributions to the class (Craven & Hogan, 2001). When grading classroom participation, instructors need to be sure they give every student a fair opportunity to participate (Bean & Peterson, 1998). For the shy and quiet students, being prepared is very important. Assigning "guided journals" where students write their responses before class and share their comments in class is a way of helping these introverted students to be more comfortable in participating in class (Bean, 1996). Other techniques instructors may use to increase the level of student classroom participation include allowing e-mail entries to be part of class participation (Meacham, 1994); coaching the quiet students to be more active participants in class; allowing at least one minute of silence after posing questions for students to prepare their responses; and allowing students to submit comment cards of their written responses of class questions (Bean & Peterson, 1998).

Barber (1995) was on target when she concluded that intervention alone is not the final answer to increasing the number of women in engineering. The fact that science functions as a masculine field creates an internal frostiness that does not invite women into this circle. Its culture values independence, emotional toughness, objectivity and rational thought, which are associated with the masculine identity. Understanding the connection of science to masculinity may be the key to comprehending why there are so few women in engineering. By sending the message to women that they need to choose between careers in engineering or be true to their identity as women, society is not encouraging them to pursue engineering as a career. The culture of science was designed to fit the needs of men however; it can be redesigned to include the needs of women. This practice would very likely increase the number of women in engineering.

The goal should not be to change women's values and ways of thinking to fit that of men. Instead the goal should be to strive to challenge the culture within engineering to fit the needs of women as well as men (Barber, 1995; Blaisdell, 1995). Our goal should be to diversify and excel by elevating to the next level, not to assimilate and keep the same level of quality. On a positive note, such change is not impossible to accomplish although it is not going to arrive without challenges. If we do not get started soon, it definitely will take a couple generations before significant changes in the current gender gap within engineering are visible (Barber, 1995). The benefits of these recommendations for men, women, and society are quite clear. What does not make sense is why these recommendations are not yet implemented.

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APPENDIX A

STUDENT E-MAIL INVITATION

Find out what your personality type and learning styles are!

This is a great opportunity to try out tools that are used in industry and to participate in a workshop that explains the results to you.

Attend a workshop where you take the Myers-Briggs survey (used in industry to help place people effectively) and other surveys as a part of a study being done by Anita Persaud for her doctoral work in Counselor Education. Her study includes four brief surveys, which may take approximately 20-30 minutes to complete. Your information will be integrated anonymously into Anita's data to help understand women's experiences in engineering.

Date: **Wednesday, October 8th** OR **Thursday October 9th**
Time: 6:00 – 7:00 p.m.
Place: 306 Hammond Bldg

A week later, Anita will present a workshop (presented twice for your scheduling convenience) to interpret your learning styles (one of the instruments you would have completed).

In all educational fields and especially engineering as a major and a career, you will increasingly need to have a better understanding of your learning, work and communication styles. Such an understanding can greatly assist in your success in the future.

Please RSVP to Anita Persaud at apersaud@engr.psu.edu (865-6613) by Monday, October 7th regarding which date you will attend. Include this information:

Your major:
Your semester standing:

APPENDIX B

INFORMED CONSENT FORM

Informed Consent Form for Behavioral Research Study

The Pennsylvania State University

Title of Project

Our Silenced Intellects: To What Extent Do Gender Identity, Learning Styles and Classroom Climate Influence Involvement of Today's Women Students in the College of Engineering.

Persons in Charge

Anita Persaud
208 Hammond Bldg.
865-6613
apersaud@engr.psu.edu

Dr. Daniel Salter
330 CEDAR Bldg.
865-3428
dws11@psu.edu

Office for Research Protections
(814) 865-1775
Please call the ORP for questions regarding your *rights as a research participant.*

Explanation of Study

The study in which you are participating is part of research intended to understand how the differences between students interact with differences between classroom settings. If you agree to take part in this research, you will be asked to complete four instruments, which should take no longer than 30 minutes. The *Myers-Briggs Type Indicator* provides an indicator of learning style, the *Salter Environmental Type Assessment* assesses a classroom environment of your choosing, the *Classroom Involvement Scale* assesses your classroom participation, and *the Gender Scale* measures your gender identification. There are no risks involved in your participation beyond those experienced in everyday life. You might learn more about yourself by participating in this study. In return for your participation you will be invited to attend a Myers-Briggs Type workshop in order to interpret your learning style profile.

Your Rights as a Participant

You may ask questions about this research at any point. You should direct your questions to Anita Persaud. Your results will be kept confidential, and only Anita Persaud and her Doctoral Adviser; Dr. Daniel Salter will see your result. In the event of publication of these results, only group summaries will be reported. No identifying information will be disclosed. Your participation is voluntary. It is your right to decline to answer specific questions if you choose. If you decide not to participate in this study, you may return unused materials to Anita Persaud without any further questions or penalty.

Informed Consent Form

The Pennsylvania State University

This is to certify that I, (please print) ____________________________, agree to participate in the scientific investigation of student/classroom involvement, as an authorized part of the education and research program of the Pennsylvania State University. I understand the information given to me, and I have received answers to any questions I may have had about the research procedure. I understand and agree to the conditions of this study as described. To the best of my knowledge and belief, I have no physical or mental illness or difficulties that would increase the risk to me of participating in this study. I understand that I am invited to a Myers-Briggs Type workshop to learn about my learning style and I understand there is no other compensation for my participation. I also understand that my participation in this research is voluntary and that I may withdraw from this study at any time by returning the unused materials. I am 18 years of age or older.

I understand that I am to keep a copy of this consent form.

Student Signature______________________________________ Date____________________

I certify that the informed consent procedure has been followed, and that I have answered any questions from the participant above as fully as possible.

Anita Persaud, M. Ed. __________________________________ Date_____________________

APPENDIX C

DEMOGRAPHICS INFORMATION SHEET

Demographics Information Sheet

Please take a moment to complete this demographics sheet. The information you share is optional and will be pooled together for statistical purposes. Thus, your individual responses will not be identified in the research summary.

Fill-in, check or circle the appropriate answer for each category

Age: _____

Major: _________________________ (e.g., A. E., Chem. E., E. E., M. E. etc.)

Class Standing: First-Year Sophomore Junior Senior 5th Year Senior

Cumulative GPA: _____

Racial/Ethnic identification (check all that apply):

_____ American Indian/Alaskan Native
_____ Black/African American
_____ Asian-Pacific American
_____ Hispanic American or Puerto Rican
_____ White American
_____ International Student
_____ Other (Please specify)

Estimated Family Annual Income:
_____ Less than $8,000 per year
_____ $8,001 - $18,000 per year
_____$18,001 - $28,000 per year
_____ $28,001 - $40.000 per year
_____ $40,001 - $55,000 per year
_____ Over $55,000 per year

Are you the first in your family to attend college?
___Yes ___No

Do you have any relative(s) who have earned a college degree in Engineering?
___Yes ___No

Did you attend a co-educational high school?
___Yes ___No

How would you describe your hometown?
___Urban ___Rural ___ Suburban

APPENDIX D

Description of MBTI & SETA Dimensions

Extraversion-Introversion (E-I) Dimension

Extraverted Students	*Introverted Students*
Are comfortable in the classroom and exude autonomy and self-confidence. May seem too dominant and assertive at times	Prefer some independence and tend to be self-reliant and private students. May seem anxious or accommodating.
Extraverted Classrooms	*Introverted Classrooms*
Requires attention and participation of the students. Serves as a catalyst for a broad array of events and activities. May be loud, noisy, bright and/or social.	Allows students to regulate the extent of their interactions. Offers opportunities for private actions and individual functioning. May seem subdued, quiet, sedate, and reserved.

Sensing-Intuition (S-N) Dimension

Sensing Students	*Intuitive Student*
Seek the fullest possible experience of what is immediate and real. Focus on the experiences that are available to their five senses.	Seek the furthest reaches of the possible and imaginative. Perceive what is beyond the senses, including future events.
Sensing Classrooms	*Intuitive Classrooms*
Focus on learning existent knowledge and skills. Course content is identified for its practical application.	Experimentation would be expected. Students would be rewarded for creativity and/or discovery of new and novel information.

Thinking-Feeling (T-F) Dimension

Thinking Students

Seek order in accord with the nonpersonal logic of cause and effect. Rely on impartiality and neutrality with respect to people affected by decisions.

Feeling Students

Seek order in accord with the creation and maintenance of harmony among important subjective values. Relies on an understanding of personal and group values.

Thinking Classrooms

Contains objective sets of logical operations that are based on a central, depersonalized truth or science. Detached appraisal is rewarded.

Feelings Classrooms

Emphasizes "connectiveness" and stresses values and interpersonal interactions. Rewards interpersonal skills and subjective decisions.

Judging-Perceiving (J-P) Dimension

Students with Judging

Prefer to have order in the environment. Respectful of the rules. Seen as responsible and in control of self.

Students with Perceiving

Tend to be flexible, open to change. As students, they like a lot of variety and may take many risks.

Judging Classrooms

Are orderly and planned, both in operation and organization. Systems (e.g., policies and procedures) help to maintain a coherent reality but may become fixed and stagnant.

Perceiving Classrooms

Focuses on the elements in the classroom (e.g., facts, theories, students). Sometimes, efforts to change and grow may make the class seem disordered.

*adapted from Myers, McCaulley, Quenk & Hammer (1998) and Salter (2000a)

APPENDIX E

GENDER INTERCONNECTION SCALE

(Reprinted with Permission of the Author, Janet K. Swim, Ph.D.)

Please read the following statements and indicate the extent of your agreement or disagreement by circling the appropriate number.

-3	-2	-1	0	1	2	3
strongly disagree			**neither agree nor disagree**			**strongly agree**

1.	I think that I am very different from most Women.	-3	-2	-1	0	1	2	3
2.	I seek out information about Women’s issues in America.	-3	-2	-1	0	1	2	3
3.	I don't have a lot in common with Women.	-3	-2	-1	0	1	2	3
4.	I have difficulty identifying with Women.	-3	-2	-1	0	1	2	3
5.	I really have not spent much time trying to learn more about Women’s issues.	-3	-2	-1	0	1	2	3
6.	I am very concerned about the problems Women have in today's society.	-3	-2	-1	0	1	2	3
7.	When electing public officials, I would vote for candidates who I know consider issues that affect Women.	-3	-2	-1	0	1	2	3
8.	I think a lot about how Women's lives will be affected by their gender group membership.	-3	-2	-1	0	1	2	3
9.	I think I have much in common with Women.	-3	-2	-1	0	1	2	3
10.	I have learned a lot about the history and tradition of Women.	-3	-2	-1	0	1	2	3
11.	I don’t feel much of a connection to Women.	-3	-2	-1	0	1	2	3
12.	I don't think I would be interested in taking a course on the history of Women in America.	-3	-2	-1	0	1	2	3

1.	I think that I am very different from most Men.	-3	-2	-1	0	1	2	3
2.	I seek out information about Men’s issues.	-3	-2	-1	0	1	2	3
3.	I don't have a lot in common with Men.	-3	-2	-1	0	1	2	3
4.	I have difficulty identifying with Men.	-3	-2	-1	0	1	2	3
5.	I really have not spent much time trying to learn more about Men’s issues.	-3	-2	-1	0	1	2	3
6.	I am very concerned about the problems Men have in today's society.	-3	-2	-1	0	1	2	3
7.	When electing public officials, I would vote for candidates who I know consider issues that affect Men.	-3	-2	-1	0	1	2	3
8.	I think a lot about how Men's lives will be affected by their gender group membership.	-3	-2	-1	0	1	2	3
9.	I think I have much in common with Men.	-3	-2	-1	0	1	2	3
10.	I have learned a lot about the history and tradition of Men.	-3	-2	-1	0	1	2	3
11.	I don’t feel much of a connection to Men.	-3	-2	-1	0	1	2	3
12.	I don't think I would be interested in taking a course on the history of Men in America.	-3	-2	-1	0	1	2	3

APPENDIX F

CLASSROOM INVOLVEMENT SURVEY

Classroom Involvement Survey

Consider the same class you thought of when completing the Salter Environmental Type Assessment (**SETA)** as you complete this survey. Please rate the following statements on a scale from –2 to +2, or NA where:

-2=strongly disagree, -1=disagree, 0=neutral, 1=agree, 2=strongly agree, and NA= Not Applicable

Circle the number that best describes your experiences

Part I

1. I was an active participant in class discussions. -2 -1 0 1 2 NA
2. I often raised questions in class. -2 -1 0 1 2 NA
3. I contributed ideas in class. -2 -1 0 1 2 NA
4. I had to answer questions from the instructor during class. -2 -1 0 1 2 NA
5. The instructor valued my contributions. -2 -1 0 1 2 NA
6. The other students welcomed my classroom participation. -2 -1 0 1 2 NA
7. People listened to me when I spoke in class. -2 -1 0 1 2 NA
8. I felt engaged as a learner in class. -2 -1 0 1 2 NA
9. My assertiveness assisted me in participating in class. -2 -1 0 1 2 NA
10. I worked on group activities during class time. -2 -1 0 1 2 NA
11. I worked on group projects with classmates *outside* of class. -2 -1 0 1 2 NA
12. I discussed course concepts with classmates *outside* of class. -2 -1 0 1 2 NA
13. I assisted classmates by explaining course concepts *outside* of class. -2 -1 0 1 2 NA

14 Classmates assisted me by explaining course concepts *outside* of class. -2 -1 0 1 2 NA

15. Students could receive participation points for their contributions. -2 -1 0 1 2 NA
16. The class material was at my level of understanding. -2 -1 0 1 2 NA
17. The classroom atmosphere was more collaborative than competitive. -2 -1 0 1 2 NA
18. There was time to ask questions during class. -2 -1 0 1 2 NA

Part II

Approximate number of students in class _____
Sex of class instructor (circle one) Male or Female
*Location of class (specific campus/university)*____

VITA

Anita Persaud

Born: April 1, 1971
Guyana, South America

EDUCATION

Doctor of Education in Counselor Education: College Student Personnel **1/00-8/03**
Department of Counselor Education, Counseling Psychology and Rehabilitation Services,
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Department of Counselor Education, Counseling Psychology and Rehabilitation Services,
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Bachelor of Arts in Psychology **6/94**
Queens College, New York, NY
Senior Thesis: Persaud, A. (1994). Adolescent sexual activity: risk factors.

Martin Van Buren High School **5/90**
Queens Village, New York, NY

EXPERIENCE

Assistant Director, **10/01-Present**
The Minority Engineering Program, The College of Engineering

Advising Programs Coordinator, **5/99-10/01**
The Educational Opportunity Program

Interim Director, **2/00-5/00**
The Educational Opportunity Program

Counselor, The Multicultural Resource Center **1/99-5/99**
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CONFERENCE PRESENTATIONS

- Persaud, A. (February, 2001). *Gender inequity in today's college classroom.* Poster presented at the Penn State Black Graduate Student Association's Achievement Conference, State College, PA.

- Persaud, A. & Salter, D. (March, 1999). *Warming-up the chilly classroom through the use of Jungian constructs.* Paper presented at the American College Personnel Association (ACPA) Conference in Atlanta, GA.

- Persaud, A. (February, 1999). *Gender inequity in today's college classroom: Understanding women's participation.* Paper presented at the National Association for Women in Education (NAWE) Conference, Denver, CO.

- Persaud, A., R. C. Intrieri, S.L. Willis, and K.W. Schaie (November, 1995). *Practical intelligence: Still stable over all these years?* Paper presented at the annual meeting of the Gerontological Society of America, Los Angeles, CA.