Having Their Voices Heard: Women Engineering Students' Answers To Why The Classroom Climate Is *Still* Chilly

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Abstract — This study examined the relationship between women's level of gender identity, preference in learning styles, and perception of the classroom environment and how these factors affect each other as well as their self-reported level of classroom involvement in core engineering courses. Although most engineering classrooms tend to be *Introverted-Thinking*, results from this study show that women students benefit from *Extraverted-Feeling* classroom environments. Particularly, they strive when there are hands-on demonstrations, real world applications of concepts, group work and class discussions.

Statement of the Problem

Although women attend college in greater numbers than men, they are still underrepresented in physics, computer science and engineering (Felder, Felder, Mauney, Hamrin & Dietz, 1995; Hall & Sandler, 1982). Such chilly institutional climates for women result in lower reported gains in academic success when compared to women who do not perceive a chilly institutional climate (Salter, 2002). 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 (Forsyth, 1999). Women students prefer classroom environments with group work and collaboration rather than competition and individual work which is how most engineering courses are designed (Felder et al., 1995).

The purposes of this study are to clearly recognize the factors that may contribute to the attrition of female students in engineering, to seek concrete recommendations from faculty in order to improve their enrollment and retention rates and to share this information with others in the field of engineering. 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 (Persaud & Salter, 2004). Specifically, these researchers focused on how learning styles, classroom environment and gender interconnection of female students influence their level of classroom involvement (Persaud & Salter, 2004) and to what extent is the engineering classroom female friendly.

Participants

The volunteer sample for this study was 146 full-time undergraduate female students from the College of Engineering, ranging in age from 17-27 and represented different cultural and ethic backgrounds.

Instrumentation & Analysis

A Demographic Information Sheet was used to obtain relevant background information. The Myers-Briggs Type Indicator (MBTI) Form M was used as a measure of learning styles. The SETA-Experimental Form B (Salter, 2002) was used to assess classroom environment. The SETA assessment was developed to work hand-in-hand with the MBTI. Using the same dimensions (E-I, S-N, T-F, & J-P) to focus on the environment rather than learning styles. The Gender Interconnection Scale (GIS) was used to measure gender interconnection (Swim, 2002). The Classroom Involvement Survey (CIS) was designed to assess the level of college students' participation in classroom environments. Stepwise-multiple regression analysis was implemented via SPSS 11 and Nudist Vivo was used to analyze the qualitative component of the study.

Male engineering students were not included in this study because the researchers did not want to establish males as the *norm* upon which to compare women. If men are considered to be the *norm* or *normal*, then it is implied that women are not *normal*. The intent is not to declare such a sexist statement.

Results & Discussion

Results indicate that higher SETA-T/F values are associated with higher perceived classroom involvement values (partial r =. 392, p=.000, n=146). In other words, the *feeling* classroom environments were associated with higher degrees of classroom involvement from female students compared to the *thinking* classroom environments (Persaud & Salter, 2004). It is easy to imagine that the feeling oriented classrooms, especially the extraverted ones, to be more open to student participation (Barrett, 1989).

The qualitative component included three questions: a) What should start happening in this course to increase student involvement? b) What should continue happening in this course to increase student involvement? and c) What should stop happening in this course to increase student involvement? Nudist Vivo (Nvivo) was used to analyze this component of the study.

A total of 22 nodes were identified. These 22 nodes resulted from the open coding. Careful review of these nodes was conducted by the researches. In the process of looking of underlying similar concepts between the nodes (e.g. one of the open codes was labeled tests/quizzes and another one was labeled difficult exams). Both related to tests/exams and so they were combined because the researchers were looking for similar concepts. Eventually the researchers looked for similar threads of open nodes and after a series of iterations with the comments, four axial emerged (interactive classes; instructor; small classes and group activities).

The women's comments are intriguing and can be very useful when designing workshops for engineering and science faulty which focus on successful teaching strategies. Adapting just a few recommendations per semester would lead to an overall better teaching and learning environment for both students and faculty. Here are a few examples of the women's quoted comments to what needs to start happening in the course to increase student participation.

Interactive classes:

Make time to answer students' questions
Allow students to ask questions
Encourage students to sit at front of the room

Instructor:

Face class as teach
Use reward system (participation/homework credit)
Ask questions instead of just telling answers
Treat students with compassion & respect

Classes:

Smaller classes (400 students in lecture halls)
Do not use power-point presentations
Nobody wants to learn Physics at 8 a.m.

Group activities:

More collaborative environment
More group work
Solving problems in class in small groups
More hands on activities (do problems on the board)

Based upon the students' comments, it is clear that female engineering students prefer smaller, interactive classes with many hands-on demonstrations and group activities. Most importantly, it is clear that instructors create an environment that either support or hinder learning.

Although the only MBTI dimension that shows clear gender difference is the Thinking-Feeling dimension (Thinking is approximately 60% of males while Feeling is approximately 60% of females), the women engineering majors did not show this trend. Instead there was a closer split of T=43% and F= 57% (See Table I). One explanation for this trend could be that the field 'selects' a higher percentage of Thinking type students. It would be interesting to look at the T/F percentages for women engineering graduates.

Table I

MBTI Type Table of Frequency and Percentage Distribution of Four Dimensions (n=146)

Scale		E	I	S	N	T	F	J	P
MBTI	Frequency	88	58	64	82	63	83	83	63
	Percent	60.3	39.7	43.8	56.2	43.2	56.8	56.8	43.2

Conclusions

The purpose of this qualitative study was to address the unrelenting cycle where women students encountered a chilly classroom climate. This chilliness discourages them from entering nontraditional fields, which continues the cycle of women being confined to a minority status in the classroom as well as in the field. Unlike previous studies, this study examined the relationship between women's level of gender identity, preference in learning styles and perception of the classroom environment and how these factors affect each other as well as women's self-reported level of classroom involvement in core engineering courses.

It is encouraging to know that the factors which can encourage or discourage learning in the engineering classroom are all things that can be easily remedied by changes made specifically in faculty teaching style and behaviors towards students. It is uplifting to know this fact because there are many interventions that can occur for faculty in assisting them to improve their teaching styles.

Although engineering classrooms are mainly introverted-thinking environments (Felder, Felder & Dietz, 2002), in this study, extraverted-feeling environments had more positive benefits for female students. The Extraverted-Feeling classroom environment tends to have higher levels of female student classroom involvement. Also, the extraverts tend to like and adjust to group-work better than the introverts, and women tend to be extraverts. Interestingly, feelers are more likely than thinkers to drop out of the field although they may be doing just as well academically (Felder et al., 2002). Realizing that students learn more when they are actively involved in the classroom leads to the clear objective of creating extraverted-feeling classroom environments in all disciplines (Persaud & Salter, 2004).

The major finding from this study is that women students thrive on cooperative/collaborative learning environments in the engineering classroom. This finding coincides with results from other studies which indicate that girls learn math and science more effectively when taught in small-groups, and activity based learning (Clewell & Campbell, 2002). This is a critical finding because studies have indicated that in the United States approximately half of all employees are members of group or team projects (Forsyth, 1999). In order to prepare our students for their future work environments, it makes sense to assign them to work in groups as undergraduates (Thomas, 2001; Terenzini, Cabrera & Colbeck 1999).

It is important to remember that such environments need to be monitored by faculty because it could hinder as well as promote gender equity in the classroom. In groups where women are the minority, men may overlook their valuable input (Burrowes, 2001). Also, the men usually take the lead to explain and answer the problems, while the women are left as the passive recipients (Cranston, 1989). Active involvement in learning is the key to understanding and truly learning the material (Felder et al., 1995). In another study, both men and women saw the benefit of teamwork in terms of reducing the overall workload, however teamwork was viewed more positively by women in that they saw it as learning benefits and as access to the 'boys network' (Burrowes, 2001).

The encouraging realization in this study is that what students say will make the classroom more interactive are primarily suggestions that faculty have control over. Therefore, it will not be an unending feat for faulty to meet the needs to these students. All that we have to do is seriously consider the students' recommendations and try to be conscious of a few of these strategies when teaching. Not only will women students benefit, but all students, including underrepresented ethnic minority students as well as white male students will receive the learning benefits.

Based on this study's findings, it is the responsibility of higher education administrators to facilitate the faculty in understanding how they can design their classroom environments to be more *feeling* & *extraverted* (Persaud & Salter, 2004) while incorporating a few of the students' recommendations in order to increase student involvement and overall learning. Such change in classroom environments may lead to greater recruitment, enrollment, retention and graduation rates of not only women engineering students, but all students. The recommendations provided will benefit all students pursuing degrees in nontraditional fields.

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