



## **CHANGE: MOTIVATIONAL FACTORS FOR WOMEN IN ENGINEERING: SELF-EFFICACY AND ACADEMIC SELF-CONFIDENCE**

### **Overview of the Research**

While attracting women into engineering programs remains an imperative, retaining and graduating those who do enroll remains crucial. Those women who leave engineering usually attribute their departure to alternative choices rather than poor academic performance [1]. The majority of the time these women obtain their degrees in other science majors, indicating that the engineering pipeline may be discouraging women [1,2].

Limited progress has been made.

Representation of women has moved from 11% of all employed scientists and engineers in 1987, when the Federal government formed the Task Force on Women, Minorities, and the Handicapped in Science and Technology, to approximately 20% of the recipients of bachelor's master's, and doctoral degrees in engineering today [3, 4]. Nonetheless, the question remains as to why underrepresentation of women remains so persistent in engineering.

Perhaps the answer lies, in part, within the concepts of self-efficacy and academic confidence which are among the greatest predictors of success in engineering programs [5-8].

### **Academic Confidence, Self-efficacy Student's Motivation to Succeed**

From motivational psychology, belief in self can be measured by two interrelated constructs: academic self-confidence and self-efficacy. An individual's self confidence is derived from affective memories of past experiences of engaging in an activity or upon judgments of one's capabilities to organize and execute courses of action to attain specific goals [9]. Research has shown that people with positive self views can overcome great obstacles to achieve success while people with lower levels of self-esteem or negative self-conceptions fail to reach their fullest potential [10]. A student's persistence will depend upon continual reaffirmation of positive self-beliefs about his or her chances for successful completion.

In Seymour and Hewitt's study, females' difficulties were noticed by their male peers who commented on the women's lack of confidence in engineering classes. The men's response, not particularly supportive of the women, was to assert that the women should either hide their lack of confidence or overcome it [1]. This response by their male peers could serve to further undermine female's belief they belong and can succeed in engineering programs [5].

Academic self-confidence and self-efficacy are not mutually distinct. Both can lead to favorable progress in an engineering degree program [5,6]. However a defining aspect of self-efficacy, which distinguishes it from the general notion of academic self-concept, is its domain specific nature. While academic confidence is more resilient, an individual's

perception of self-efficacy will differ from domain to domain, and within a domain, from context to context. Therefore, if a student's self-efficacy is threatened within a domain (i.e., major), they may switch to another. This may be due the inter-relationship between self-efficacy and effort wherein if self-efficacy lags, effort will decline [6].

The concept of "effort" defined as willingness to devote substantial time and attention to a task is also germane. (Note that this definition of effort distinguishes it from current knowledge or innate ability. For example, male students tend to have greater special skills than female students, but females can improve their special skills through practice and effort.) Completion of an engineering program requires a great deal of effort because it is a difficult endeavor. However, past studies generally found that females attributed insufficient effort as the cause of their academic successes in male domains [11]. Although effort is a positive academic trait, increased effort in the male domain of engineering may be interpreted as compensation for less innate ability. This could present a major stumbling block for females in that they may be tempted to assume they do not have what it takes to succeed.

Self-efficacy may be enhanced or diminished due to feedback from external factors such as social factors, support systems, climate of the classroom, and available resources [12,13]. If classrooms give negative or intimidating messages while offering little support, how well women weather the storm may depend on their resilience. Women who internalize this discouragement are at risk; those who develop an oppositional consciousness (e.g., I'll show you!) have a much better chance of success. Bem [14] defined "oppositional consciousness" as a challenge to the group stereotype assigned by the dominant culture. Teaching oppositional consciousness is one strategy by which to acclimatize women to engineering courses.

### **Teacher Self-Efficacy**

Teacher self-efficacy is of potential concern for engineering educators, especially junior faculty or faculty in a research university where teaching is given a low priority. Teacher self-efficacy refers to a teacher's belief that he or she can positively change the outcomes for struggling students. This requires a great commitment to students [15]. However, due to the nature of competitive university engineering programs, professors may lack sufficient incentives to work overtime with struggling students. Moreover, teaching assistants are frequently not trained to be effective teachers, thus struggling students are often not given the proper help. This leads to their poor classroom performance which does little to enhance the self-efficacy giving them



little incentive to continue to apply the needed effort to succeed.

### Recommended Actions for Change

- **Watch Unconscious Gender Biases**

According to Zeldin and Pajares, social cues can subtly dissuade women from pursuing studies in engineering [16]. One cannot underestimate the effects of classroom environment and teachers' behaviors on females' self-efficacy. Recent research has shown that although women in engineering tend to have lowered self-efficacy in engineering [1,5,8], when women felt academically integrated in their classrooms and felt professors were personable, their engineering self-efficacy did not lag behind men's as in previous studies [6].

- **Beware of Subtle Messages Given to Students**

Professors can give subtle messages about a student's competence without being aware of the implications. For example, students believed to be less capable are given less wait time to respond to a question, asked easier questions and given more disingenuous praise. Moreover, giving students less autonomy in their work can also convey a lack of respect [15].

- **Emphasize Effort as More Important than Innate Ability**

Although professors often look for the superb students, self-efficacy is a better predictor of grades than is innate ability [17]. Therefore, students should understand that they are all capable and that effort is needed to achieve.

- **Keep Instruction One Step Above Students' Current Levels of Functioning**

Determine the students' current level of understanding on a topic and teach concepts just beyond their understanding so they are challenged rather than frustrated or bored with new information. This ensures that they remain motivated and will continue to exert the necessary effort to succeed [17].

- **Consider More People-oriented Projects**

Consider projects with more human appeal and teamwork. Self-efficacy is linked to intrinsic motivation, which relates to the amount of interest or enjoyment a student has in a topic and factors strongly into persistence in a field. However, due to females' perception of engineering as inhumane and mechanistic, females' interest could wane because they usually have more interest in human-oriented engineering [18].

### References

- [1] Seymour, E. and N.M. Hewitt, *Talking about Leaving: Why Undergraduates Leave the Sciences*, Boulder, Colorado: Westview Press, 1997.
- [2] Huang, G. Taddese, N. & Walter, E. (2000). *Entry and Persistence of Women and Minorities in College Science and Engineering Education*. National Center for Educational Statistics Research Report NCES 2000-601.
- [3] United States. Congress. The Task Force on Women, Minorities, and the Handicapped in Science and Technology.

(1989). *Changing America: The New Face of Science and Engineering*, Washington, D.C.

[4] Gibbons, M. (2004). The year in numbers. A report from the American Society of Engineering Education. Retrieved March 2004 from <http://www.http://www.asee.org/about/publications/profiles/index.cfm>

[5] Vogt, C., "An Account of Women's Progress in Engineering: A Social Cognitive Perspective," *Journal of Women and Minorities in Science and Engineering*, Vol. 9, Nos. 3/4, 2003, pp. 217-238.

[6] Vogt, C., D. Hocevar and L. Hagedorn, "A Social Cognitive Construct Validation: Determining Women and Men's Success in Engineering Programs," *Journal of Higher Education*, Vol 78, No. 3, 2007, pp. 336-364.

[7] French, B.F., J.C. Immekus, and W.C. Oakes, "An Examination of the Indicators of Engineering Students' Success and Persistence," *Journal of Engineering Education*, Vol. 94, 2005, pp. 419-425.

[8] "A Comprehensive Evaluation of Women in Engineering Programs," [http://www.grginc.com/WECE\\_FINAL\\_REPORT.pdf](http://www.grginc.com/WECE_FINAL_REPORT.pdf)

[9] Bandura, A., *Social Foundations of Thought and Action: A Social Cognitive Theory*, Englewood Cliffs, New Jersey: Prentice Hall.

[10] Bong, M. and R.E. Clark, "Comparison between Self-concept and Self-efficacy in Academic Motivation Research," *Educational Psychologist*, Vol. 34, No. 3, 1999, pp. 139-153.

[11] Swim, J. K. & Sanna, L. J. (1996). He's skilled, She's lucky: A meta-analysis of observers' attributions for women and men's successes and failures. *Personality and Social Psychology Bulletin*; 22(5), 507-519.

[12] Pajares, F., "Self-efficacy Beliefs in Academic Settings," *Review of Educational Research*, Vol. 66, No. 4, 1996, pp. 543-578.

[13] Zimmerman, B., "A Social Cognitive View of Self-regulated Academic Learning," *Journal of Educational Psychology*, Vol. 81, No. 3, 1989, pp. 329-343.

[14] Bem, Sandra, 1993, *The Lenses of Gender*, New Haven: Yale University Press.

[15] Woolfolk, A. (2005). *Educational Psychology* 9<sup>th</sup> Edition. Allyn & Bacon: Boston, MA.

[16] Zeldin, A. & F. Pajares, (2000). "Against the Odds: Self-Efficacy Beliefs of Women in Mathematical, Scientific, and Technical Careers," *American Educational Research Journal*, 37(1), 215-246.

[17] Schunk, D.H., *Learning Theories: An Educational Perspective*. Upper Saddle River, New Jersey: Pearson, Merrill Prentice Hall, 2004.

[18] Margolis, J. Fisher, A. & Miller, F. (2002). "Caring about connections: Gender and computing." School of Computer Science, Pittsburgh, Pennsylvania: Carnegie Mellon University.

CHANGE – Change and Awareness Necessary for Global Engineering

Prepared by Series Editor: Dr. Christina Vogt,  
EEES Scholar-in-Residence

Additional Information: Dr. Norman L. Fortenberry, EEES PI

Email: [nfortenb@nae.edu](mailto:nfortenb@nae.edu) Web: <http://www.nae.edu/CASEE>



This work is partially funded under NSF Grant Number HRD-0533530