Retention Discussion

RETENTION OF WOMEN IN UNDERGRADUATE ENGINEERING PROGRAMS: AN EMPIRICAL INVESTIGATION OF THE ROLE OF EDUCATIONAL RESILIENCE

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Abstract -- The under-representation of women in undergraduate science, mathematics, engineering, and technology (SMET) programs has been the source of a large number of inquiries in recent years. Much progress has been made in the identification of obstacles working against the participation of women in undergraduate SMET disciplines. However, despite the myriad of obstacles, a number of women persist and persevere in engineering disciplines, even after initially encountering difficulty. This phenomena is perhaps best explained by the concept of educational resilience, the ability to thrive in the face of adverse circumstances. The present paper describes a study currently underway designed to examine the role of educational resilience in the retention of women engineering undergraduates who have encountered academic difficulty. First, the current literature on the participation of women in undergraduate SMET programs is summarized. Next, the concept of educational resilience is discussed and possible characteristics of resilient students are presented. Finally, the design methodology for a qualitative investigation of educational resilience currently underway is described.

Index Terms -- Engineering education, Resilience, Undergraduate education, Women

Women have long been grossly underrepresented in science, mathematics, engineering, and technology (SMET) higher education throughout the United States and Europe [1], particularly in the field of engineering [2]. This under-representation is due not only to the low numbers of women entering engineering programs, but also to the fact that "female students withdraw from engineering courses before graduation in greater numbers than from other courses of study"[2, p. 71].

The reason for the low retention of women in engineering programs is not lack of ability. Women have been found to receive better grades than men across all education levels [3], even in math, which has been traditionally considered a male subject [4]. Rather, the reason for low retention of women is most often conceptualized as being non-cognitive in nature. Traditionally, the culture of higher education, SMET in particular, has excluded women [5], as engineers, scientists, and their ilk wield a degree of status and power historically not associated with women [6]. Women are not likely to feel comfortable in these traditionally male arenas [7], and often encounter obstacles such as lack of support or respect, feelings of exclusion, and overt sexist behavior [6]. The lack of significant female role models is likely another major factor. In one study it was discovered that only 5 out of 127 engineering faculty members at a Research 1 Institution were female [6].

Some improvement in the retention of women in engineering programs has been recently noted. It is not known, however, whether these improvements are reflective of an increased interest in engineering or merely due to the overall higher numbers of women entering higher education. The fact remains that the inclusion of women greatly enhances the academic enterprise [8], and that their exclusion from SMET in higher education is a detriment to the field.

To address the under-representation of women in engineering, a number of initiatives have been started in several nations. These initiatives typically include programs which address the following three goals: 1) Encouraging women to enter SMET disciplines 2) Providing support for women currently enrolled in SMET, and 3) Attempting to change SMET teaching and culture to make it more representative [1]. While many of these initiatives have focused primarily on recruitment, Cronin and Roger [1] have pointed out that it is insufficient to only recruit more women into SMET – to make an impact, women must be retained to graduation.

RETENTION OF WOMEN ENGINEERS

To better understand how women students can be retained in SMET undergraduate programs, it may be useful to turn to the current literature available on the process of retention. It has been found that the extent to which students feel invested, connected, and involved with their program strongly correlates with how likely they are to be retained [9]. The more integrated students feel in the academic community, the more likely they are to persist to graduation [10]. That is to say, if a student has a large number of positive experiences in the university, they will be more

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likely to remain in that university and undergraduate major [7].

EDUCATIONAL RESILIENCE

Non-cognitive variables such as those affecting retention are important to consider, especially in non-traditional SMET students, such as women and minorities [7]. One such factor which may be important in increasing the participation of women in SMET is educational resilience. Educational resilience, a term most often applied to school-aged children, is the ability to thrive in spite of adverse circumstances [12]. While some students, when met with an adverse environment or faced with a crisis such as receiving a failing grade in a required course, withdraw from the university or program, others do not. Educational resilience is therefore an increased likelihood of educational success despite personal or environmental vulnerabilities [13].

Characteristics of Resilient Students

While the majority of research on educational resilience has been conducted with school-aged children, the same concepts can be applied to undergraduates with minimal adaptation. The following characteristics of resilience are presented as possible characteristics of resilient students.

Research has shown that resilient students tend to have higher self-esteem than non-resilient students [14; 15]. They see themselves as competent and able to learn, and set high goals for themselves as a result [16; 17]. Resilient students also have been identified as having a strong internal locus of control [14; 15; 16], seeing themselves as having control over their own successes and failures. Resilient students have been identified as being actively engaged in their education, investing time and effort outside what is normally required of students [16; 18]. They are able to identify when they need help, and may proactively seek out assistance from teachers and peers [19].

Resilient students also tend to utilize support systems during times of academic stress, seeking out assistance from professors and students [20]. These students have also been described as having the strong interpersonal skills necessary for such interactions [16; 17]. Most importantly, resilient students are often characterized as adaptable; resilient students are open to new experiences and able to react appropriately when circumstances change [18]. They are able to distance themselves from negative conditions and make the best of positive situations.

Other resilience-related factors have also been noted, such as the strong effect of having a positive role model, and the fact that early negative experiences may “immunize” students to further difficulty, better ensuring their success [12].

Environmental Sources of Resilience

The presence or absence of educational resilience is also attributed to a number of environmental factors in the current literature [11]. Factors such as the student’s peer group, community influences, and the university’s culture and policies can all have both a negative or positive effect on a student’s likelihood for resilience [13]. Most notably, the extent to which a student feels that she belongs in the department has a marked effect on retention [18]. Prior research has found that women value long-term relationships in the academic community [7]. Therefore, the impact that peer networks can have in facilitating female undergraduate development and protecting against stress, by providing a stable and supportive center, is an important contributor to retention [18]. Finally, the importance of having a strong female role model is often stressed, particularly in the male-dominated culture of SMET [7].

The theoretical framework of educational resilience may help provide an explanation as to why some female engineers are retained in their undergraduate program after encountering adversity, while others are not. While some of the aforementioned characteristics of resilience reside strictly within the individual, nearly all can be addressed by current initiatives aimed at increasing the retention of women in undergraduate SMET programs. While resilience can be inherent, aspects of resilience can be taught, and the environment of the program can be made more conducive to the retention of women.

PRESENT STUDY

This study attempts to illuminate the problem of retention as it relates to women engineering students by employing the conceptual lens of educational resilience, the ability some individuals to thrive academically in spite of adverse circumstances or prior failings [12; 13]. The sample for the current study was drawn from a cohort of women engineering students at a large Research 1 university who had received a failing grade in a required course. Of these students, a number retook the failed class and continued to progress within the engineering program, while others did not retake the failed class and consequently withdrew from the engineering program. The present study attempts to examine the qualitative difference between these two groups from within the framework of educational resilience. It is hypothesized that women who retake failed classes and continue to persist in the engineering program will display higher levels of characteristics associated with educational resilience.

Previously, it had been noted that minority women who failed required courses retook them at a much greater rate than their non-minority counterparts [21]. Results from the present study corroborate with this observation, and show it to be stable across time. The qualitative differences between
minority and non-minority women’s reactions to academic
difficulty were therefore examined as a second hypothesis.
It is theorized that minority women are more likely to
display characteristics associated with educational resilience
then their non-minority counterpoints.

METHOD

Participants

Participants for this study were 153 undergraduate students
enrolled in the College of Engineering at a large state
university. These students were identified as belonging to a
single cohort (1998) and having failed at least one core
course required of all undergraduate engineering majors. Of
those selected for participation, 58 students retook all failed
classes, 75 did not retake any failed classes, and 19 students
failed multiple classes and retake at least one, but also failed
to retake at least one class.

Measures

Participants will be contacted by telephone and asked
several questions about their experience in the College of
Engineering. Specifically, interview questions are designed
to gain information regarding the previously outlined
characteristics of resilience. The interview script has been
included in Appendix A.

ANALYSIS

Verbatim interview transcripts will subjected to a content
analysis. The initial analysis will consider all students in
one group to obtain themes independent of the resilience
characteristics, independently cross-checked by 3 coders.
Second, students will be divided into “resilient” and “non-
resilient” groups, as determined by whether or not they
persisted after receiving a failing grade in a required course.
The content of these two groups’ interviews will then be
compared to test the applicability of the resilience model in
explaining retention. Finally, ethnic groups will be
compared to one another to determine the extent to which
ethnicity determines likelihood of persistence.

CONCLUSION

The importance of identifying ways in which women
undergraduate engineers successfully cope with failure
cannot be underestimated in the quest to increase the
participation of women in SMET disciplines. As some
women are able to thrive in undergraduate engineering
programs, persisting even after encountering academic
difficulties, it is likely that those same coping techniques can
be facilitated in other women. The present study represents
an attempt to discover these adaptive processes by using the
conceptual framework of educational resilience. Results
from this study will be used to suggest ways in which SMET
academic programs can be made more attractive to women
undergraduates, facilitating their participation and success in
SMET disciplines.

APPENDIX A:

Phone Script (Questions asked after consent to
participate is obtained).

1) What factors initially made you decide to enter the
engineering program? [Looking back, do you feel you made
the right decision? Why/why not? Have you ever
considered any other academic fields?]
2) What qualities do you possess that are academic
strengths? Weaknesses?
3) Have you felt like a valued member of the engineering
community at Texas A&M? [What have you noticed that
has made you feel included/excluded? Have you been
sought out by others in your program for help/support?
Have you sought out others?]
4) What have your experiences been like with the
engineering faculty? [Have you felt supported by them?
Have they made any attempts to engage you personally?
Have you made attempts to engage them? Are their any
faculty members you have felt particularly connected with?
Have you had any particularly good/bad experiences?]
5) Do you feel that your experiences with the engineering
program and its faculty have been similar to those of other
students? [Why/Why not?]
6) Practically all students encounter academic difficulty at
some time in their undergraduate career. How have you
reacted to the times you have had difficulty with classes?
[Did you seek outside help? Did you leave or consider
leaving the program? What factors played an important role
in that decision? What was helpful/difficult? If you retook
the class, what factors played a role in your decision? What
helped the second time you took the class? What was
different?]
7) What has helped you most in your experiences with the
engineering program?
8) That’s all the questions that I have listed. Is there
anything else that you think would be important to consider
in our investigation of ways in which to increase the
participation of women in the College of Engineering?

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