

## **AC 2009-975: OBSTACLES AS CHALLENGES: RETENTION OF FEMALE ENGINEERING STUDENTS IN MEXICO**

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# Obstacles as Challenges: Retention of Female Engineering Students in Mexico

## Introduction

As part of a larger study examining the experiences of female engineering students in Mexico, the purpose of this qualitative study was to explore the experiences of women college students in engineering programs in Mexico and to understand how the students reframe their experiences and remain in their programs. This study is set in a particular social context where, although the proportion of women in college has achieved parity with men, in some college programs such as engineering the proportion of males is still far greater than females. Only 24% of engineering students are female, while women constitute 50% of the total enrollment in higher education institutions in Mexico<sup>1</sup>.

It is thus important to understand how female engineering students who have persisted perceive their experiences in college. This study focused on the experiences and strengths of women in engineering programs in Mexico that helped them remain in their programs.

## Review of the Literature

Enrollment in Mexican universities has grown steadily since 1970, and has doubled in the last 20 years. However, higher education in Mexico is still a privilege-- only 22% of Mexicans between 20 and 24 years of age are enrolled in higher education institutions<sup>2</sup>, compared with the U.S. where participation in higher education among the same sector of the population is nearly 50%<sup>3</sup>. At the same time, participation of women in higher education in Mexico has improved substantially, and has nearly achieved parity with men<sup>1</sup>. However, the increased enrollment of women in higher education in Mexico does not mean that the division between traditionally "male" and "female" academic programs has disappeared. For instance, in 2006, in traditionally "female" programs such as education, women represent 66% of students, and in traditionally "male" programs such as metallurgy engineering, enrollment of women barely reaches 3%.<sup>1</sup>

Besides the low representation of women in engineering programs in Mexico, a recurring problem in engineering education is the high rate of attrition, or the rate at which students withdraw from higher education institutions without finishing a program.<sup>4</sup> The review of the documents from the universities participant in this study, as well as national statistics show that the total attrition from engineering has always been very high.<sup>5,6,7</sup> Research on women in science and engineering has also helped determine factors that contribute to female student attrition, such as the lack of female faculty and role models, especially in engineering colleges; the hostile climate of engineering colleges; and poor teaching, especially by science, math and engineering faculty.<sup>8,9,10</sup>

In addition, studies in college student retention, which address students who remain at the same institution where they start until they complete a program,<sup>4</sup> have found retention is influenced by individual and institutional factors such as student background; ethnicity; high school grades and

SAT scores; socioeconomic status; participation in social activities; faculty; size of the institution; and attachment to the institution.<sup>11,12,13</sup> For instance, Bean's<sup>13</sup> study defines self-efficacy as students' beliefs in their abilities to survive and adapt to the academic environment. He states that students who believe they can achieve their goals increase their self-confidence and can increase retention. Similarly, Dweck's<sup>14,15</sup> studies on motivation examine the role of self-conceptions in motivations and self-regulation, and their impact on academic achievement. These studies describe how female students who view intellectual ability as a quality that can be developed and not as a gift seek effective solutions in the face of difficulties, maintain their interest in learning, and are less susceptible to stereotypes.

Finally, literature on college student retention states that students who do not feel welcome into a culture are less likely to stay in college.<sup>11,16</sup> This research will focus on the experiences of women in engineering colleges in Mexico that although are aware of how Mexican culture has discouraged women from entering and succeeding in engineering professions, decided to enroll in these programs anyway, to persist, and to become active agents to change the culture.

## **Methodology**

The methodology used in this study was exploratory and descriptive with the intent to identify and describe the experiences of women engineering students in Mexico and the sources of support and strategies that helped them persist in their programs.

For this qualitative study, the investigators were the primary data-gathering instrument, in accordance with the constructivist methodology that states "The researcher, by necessity, engages in a dialectic and responsive process with the subjects under study".<sup>17</sup> To collect data 20 participants from four Mexican institutions of higher education were selected. The sample of the institutions was purposively selected based on several criteria: public and private universities, socioeconomic level, size, geographic location, and accessibility to the researcher. The institutions were visited over two trips to Mexico during the Spring and Summer of 2007. To gather information semi-structured interviews were conducted using an interview guide that was revised as the research progressed. Questions were asked regarding participants' experiences in college. The students shared thoughts, beliefs and experiences of being a woman in an engineering college in Mexico, and how they were able to "survive" in this male oriented environment. Additionally demographic information was gathered during the interviews including year and program the students were in, number of siblings and their level of education, parents' education, GPAs, and information about their high schools. In addition to interviews, to better understand the context and interpret the data, observations of students' day-to-day activities such as classes, lab work, and visits with professors were conducted. Finally, documents were reviewed and analyzed when the campuses were visited and through the Internet. These documents included university mission statements, histories of the universities, information about students' background, grades, and enrollment and attrition data.

The data collected in this study were analyzed using the constant comparative method. According to Strauss and Corbin,<sup>18</sup> and also found in Creswell,<sup>19</sup> this method involves three processes or steps in data analysis. The first step involved in the process of analyzing data is

called open coding and consists in the identification of units of data, defined by Merriam<sup>20</sup> as “any meaningful or (potential meaningful) segment of data”. Creswell<sup>19</sup> states that the process of coding data occurs during data collection, and ends up by the assignment of units of data or codes into categories. The second step in the constant comparative method is called axial coding and consists in relating categories to their subcategories to form more precise explanations of the phenomena; the term axial is used because coding occurs around the axis of a category. Initial categories were formed based on the description of the environment and the type of student experiences such as relationships with peers, professors, and institutions. The final process of coding is called selective coding, and consists in interrelating categories, or the process of integrating and refining categories at a higher level of abstraction.<sup>20</sup>

Merriam<sup>20</sup> states that “research is concerned with producing valid and reliable knowledge in an ethical manner” and validity and reliability can be approached through careful attention to conceptualization, data procedures, and findings presentation. Triangulation leads to credibility by using different sources. To assess credibility, different methods to collect data for this study were used: interviews, observations, and documents. In addition, peer debriefing was used to provide an external check of the inquiry process, to discover biases, to clarify interpretations, and to discuss possible future directions. Finally, the respondents have an opportunity to review the data gathered and provide or refine the information. This member checking technique is described by Lincoln and Guba<sup>17</sup> as the most important in establishing credibility.

## Findings and discussion

Findings of this study are based on a larger research on Mexican women students in engineering,<sup>21</sup> and illustrate how participants learned to see the hardships and obstacles they experienced as challenges which resulted in women students feeling more self-assertive and self-confident; how they negotiated the cultural expectations of females in Mexico; and how they use resistant strategies like academic success to become accepted in the male-dominated engineering environment.

Participants shared many difficulties and challenges they experienced in college. In addition to social and cultural values present in Mexican society, there is a culture in engineering colleges that influenced the experiences of participants in this study. It is noteworthy how female engineers dealt with the difficulties they encountered, and how they interpreted the meanings of those difficulties. First, participants found college very challenging academically. Of particular interest is that, in contrast with the literature that states that conceptual difficulty is one of the most discouraging factors in pursuing an engineering degree,<sup>22,23</sup> participants in this study stated that they actually *enjoyed* the academic challenge; their decision to study engineering was, in fact, *bolstered* by their self-perceived strength in and confidence to handle difficult subjects in high school, and by their desire to pursue a college major that was intellectually challenging.

... In high school I enjoyed math and physics, also chemistry. I decided that what I really wanted was engineering, I wanted a major that required intellectual challenge, and I

found mechanical engineering had the challenge. It does not limit you, I like to develop and create new things (Lucy).

Participants in general were self-confident about their intellectual capabilities. The challenge of mastering difficult subjects gave the students a sense of pride and self-confidence, and most students shared that among their best experiences were how they were able to succeed in those subjects. Liz stated, for instance,

All my positive experiences are about how I feel good when I pass all the tests with good grades, especially if the classes are difficult (Liz).

In contrast with previous studies that suggest that beliefs about abilities tend to be associated with unwillingness to persist in the face of obstacles<sup>24</sup> and in agreement with Dweck's<sup>14</sup> theory on motivation, participants in this study believed that when encountering difficult subjects what was important was the effort they put in studying and the interest they have in the subjects. Students believed that working hard allowed them to fully use their abilities. In addition, participants agreed that abilities can be developed and learned, as they stated:

... in any subject while you keep trying and if you try hard, do your homework and study for the exams [you will do fine] (Yol).

In my opinion, [any ability can be developed] maybe you just have not had the opportunity to develop it; it is not like one [person] can do it, and the other can't. I think that we all can, but it depends on the effort each one puts on it (Lul).

In the challenging engineering environment, participants looked for support and were able to develop the abilities needed to succeed in their programs. Noteworthy, all participants agreed that abilities can be developed, and they valued hard work over natural ability. They associated hard work with persistence in school, and, congruent with the literature<sup>14</sup> they developed self-confidence as they succeeded in their programs. For these students hard work translates into persistence, and they use this quality as a means of self-assertion and to overcome the cultural stereotypes they face.

Furthermore, among the challenges the students experience in college is gender discrimination coming from some peers and some faculty. Research had found<sup>22</sup> that professors and peers can drive or restrain the retention of female engineering students depending on the specific scenarios. Participants' relationships with professors varied; some professors were very supportive and encouraging and helped participants broaden their engineering views, while many participants reported discrimination and hostility with professors, especially during their first years.

Participants recognized the derogatory way some professors interacted with them, which took on specific characteristics when directed at female students. Some students reported that some faculty members insulted and humiliated students who asked questions during class. Some of the

insults were directed towards the whole class (male and female students), like a professor who told the students that “they were the worst he had ever seen” (Eve), or a professor who stated that students were “garbage” (Pao). However, in some cases the insults were directed specifically toward female students. Participants perceived that faculty had biased attitudes against women. For example, a participant shared that when she went to see a professor after class for tutoring with her female friends, the professor’s expression was “Oh! Here they come, ‘the don’t understand anything’ girls” [*¡Ay! Ya vinieron, las no entienden nada*] (Ili). This expression, as stated in Spanish, “*las no entienden nada*” associates the lack understanding of the subject with only female students. In addition, the expression: “*las no entienden nada*” which we translated into “the ‘don’t understand anything’ girls” is a form of name calling and describes the pejorative way professors addressed the female students.

Another dimension of hostility experienced by participants is how they felt ignored or discounted by professors in their engineering classes. This form of discrimination was clearly identified by the female students interviewed. For instance, Georgina explained how in a class where participation was part of the final grade, when women tried to participate in the class the professor tended to ignore them:

... there was a rejection, an excuse, the excuse was “I don’t ask you because of respect”, “you do not pass to the blackboard because of respect”, and I thought, “I want to participate, I am like them [male students]. I know the answer, I have studied”, but there was always an excuse. I saw that as a form of discrimination (Geo).

This professor’s attitude toward women is based on cultural values where woman should not be exposed or should be treated differently than men. This exclusion is seen by the participants as a form of covert discrimination.

Similarly, the students reported discrimination coming from their peers. For example, participants relayed comments their male peers made about women in engineering and about their perception that women have less ability in math and science than men. These comments were seen by male students as jokes, but for female students were taken as derogatory. Paty explained,

Once a female friend asked a question and a [male] student joked “of course, how will you be able to understand?”, then he said “it was a joke.” No, it wasn’t a joke! (Pat).

Furthermore, the image of lack of ability and distrust was covered up with a sense of protection. Participants perceived that male students’ attitudes shown as caring and protective sometimes covered attitudes of distrust or beliefs that female students were not capable or could not do required activities properly. Yolanda explains,

Well, because sometimes I think that, yes we [female students] needed to lift things or handle toxic substances in the chemistry lab, [it was] like they [male peers] didn't want [us to do it, they told us] "we will do it", maybe because, well I don't think so, well some of them because they thought I will do something wrong (Yol).

Bean<sup>10</sup> discussed how discrimination against students for any reason such as class, race, sexual orientation, or gender will lead students to feel that they do not belong or do not fit in the institution, an attitude that is closely related to the intent to leave college. Contrasting this theory participants in this study described how even though they experienced discrimination they also saw academic success as a motivating force to overcome or diminish the impact of discrimination they find in college and to affirm themselves.

At the beginning I wasn't paying attention, but the environment created the need to demonstrate that we are equal. First the [work] teams, that's typical, if they [male students] do not know you or don't know how you "can be useful" they don't even consider you, and if they don't consider you, you are like a ghost... (Pao).

Findings suggest that female students see themselves as potential actors. Congruent with Bean's study that suggests that students with an internal locus of control increase the sense of self-efficacy and self-confidence, and see good grades as a result of good study habits;<sup>11</sup> participants in this study stressed the value of persistence over natural ability, and, particularly, disassociated ability with gender. Furthermore, they saw themselves as actors rather than victims, to overcome discrimination and persist in their programs.

Tinto<sup>16</sup> discusses social interaction as one of the main pillars in college student retention. Many studies focusing on diverse settings and studies have showed that the more students engage with faculty, staff, and their peers, the more likely they will persist in college.<sup>11,25,26</sup> It is important to note that participants in this study perceived the engineering environment as individualistic and they experienced isolation. Evelin for instance, expressed her isolation in her first years of college. She stated,

In the Annex [first years] yes there were times that I was alone everywhere, always looking for the way to learn (Eve).

Furthermore, literature describes the environment in engineering as not very social.<sup>23,27,28</sup> In addition, cultural values reinforce this perception, as engineering students are perceived as nerds and not very social. Paola explains for instance,

... but in other majors, it is easier simply because they manage social relations and because it is part of their job to know each other and how to interact. In contrast, we [engineering students] even say engineers are the ones who use the library, the "ñoños" [nerds] (Pao).

Although social pressure has been documented in the literature as a cause for girls and women to lose interest in science and math,<sup>29,30</sup> participants in this study learned to live in this environment and even reframed the environment into a challenge to overcome. To engage in engineering, participants learned to negotiate culturally accepted expectations of “feminine” behaviors, and findings suggest that once in engineering, participants adapted their behaviors to conform to the masculine culture. It is noteworthy, that congruent with literature<sup>11,31,32</sup> although participants lived in a male oriented environment, they valued peer relationships, as they described the friendships and the good work teams they found in college as one of the most important factors in their persistence.

Relationships with male students] turn out to be more casual, you are with them all the time, it is like you only are with them [male students] (Oli).

With my classmates and other engineering students, yes I have good friendships; yes there is respect and a nice friendship (Liz).

In addition, female students received recognition and acceptance from their male peers for their academic success as they advance in their programs. A researcher shared in her observation notes, for instance,

[When we were visiting American University] we were waiting for a class to end in order to ask the [female] students if they were interested in participating in the study. When we entered the classroom and approached the female students, we were immediately surrounded by male students; it was kind of intimidating. It was not only that the male students were curious about the visitors and the project; it was like they were trying to protect their female peers. In addition, male students showed their pride in their female classmates, they told us that female students were better than them, ‘they [female students] are the best students [academically] [*ellas son las más aplicadas*].

Literature on women’s learning<sup>33</sup> suggests that women’s preferences are for learning that is cooperative, and studies on women in engineering<sup>22,23</sup> indicate that a competitive climate has contributed to the attrition of women students in engineering. In addition, cultural values associate femininity with care giving and cooperation. In contrast to this literature, although most participants in this study valued group work and cooperative learning, and shared how peer support was very important for their retention, findings also suggest that many of the participants like competition.

Moreover, literature on female attrition in science and engineering<sup>34,35</sup> suggests that faculty promote the elitist idea that engineering is academically very difficult and not for everyone, and expect students to prove themselves. Findings of this study suggest that participants use competition as a way to prove to themselves and to others, that they are good students and equally capable than men, and reinforce that they belong to the field.



...about the competitive environment I think sometimes it is fun, because for women it is a challenge to prove that we can do our work equal or better than others ... even among women (Yol).

Findings of this study illustrate how participants learned to see the hardships and obstacles they experienced as challenges, how they negotiated the cultural expectations of females in Mexico, and how they use resistant strategies like academic success and competition to become accepted and overcome the discrimination present in the male-dominated engineering environment.

## Conclusion

Local contexts shape the cultures of colleges and universities; furthermore individual institutional values and assumptions are inherent to institutions and can influence the experiences of students. The experiences of the female engineering participants in this study offer both challenges and opportunities to engineering colleges. Retention of female students is important for all engineering colleges, but cultural factors must be taken into consideration. The dominance of values both in the Mexican culture and in the engineering culture presents specific challenges to achieve an environment more supportive of women in Mexican engineering colleges. In addition, institutions need to be proactive and creative in order to help faculty and administrators provide an environment in which female engineering students can be successful.

Findings of this study suggest the important role that culture plays in the retention of Mexican female engineering students. Further research might identify the experiences of female engineering students in other countries and cultures analyzing differences and similarities. Of particular interest might be to compare the experiences of Mexican female students with female students from India because this country has a higher participation of females in engineering programs than Mexico and the U.S.<sup>36</sup> Similarly, a comparative study could be conducted with students in Mexico and Mexican-American students in the United States. The purpose for that study would be to help better understand the role of Latino culture in retention.

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