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SOCIALIZATION PROCESSES OF ENGINEERING STUDENTS: DIFFERENCES IN THE EXPERIENCES OF FEMALES AND MALES

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The primary purpose of this study was to explore the personal experiences of female and male engineering students in both Division I (17 females and 16 males) and Division II (11 females and 11 males) programs. Analyses of narratives of 55 undergraduate engineering students revealed that the sociocultural experiences of female and male students differ in substantial ways in that socialization processes into engineering are problematic for women, who often rely on one another to bolster their self-efficacy perceptions and resiliency. Another important finding is that Division II female students were provided much more support by both professors and male peers than were their Division I counterparts, who reported more incidents of negative interactions with male students, especially when working in collaborative groups.

Keywords: engineering education; gender; socialization

During the latter half of the twentieth century, three watershed developments in American education created more opportunities for students. The first major change occurred in 1954 when the United States Supreme Court mandated the desegregation of public schools in the Brown vs. the Board of Education decision. The second and third substantial developments occurred in 1975 and were the result of federal legislation. The Education for Handicapped Children Act (Public Law 94-142) extended services and educational opportunities for students with disabilities, while Title IX of the Education Amendments Act mandated that no students—male or female—were to be excluded from participation in activities or denied benefits of educational programs receiving federal funding.

Title IX profoundly affected public education in that today females are participating in more sports-related activities and are taking more higher-level science and mathematics courses than they did before Title IX was enacted (Sleeter & Grant, 2009). Statistics have shown how achievement levels of girls and young women in mathematics and science have improved steadily over the past thirty years, and females now perform as well as males do in mathematics and the sciences (Nieto, 2004; Willingham & Cole, 1997). Nevertheless, research on public school students' participation patterns has shown that males and females differ in their levels of classroom participation in mathematics and science (Jovanovic & King, 1998; Reid, 2000).

For example, Sadker, Sadker, and Klein (1991) found girls participate less in classroom activities after seventh grade, and they often are not as active or assertive as boys during hands-on science activities. In addition, Sadker and Sadker (1994) found teachers are more inclined to expect more compliant and passive behavior patterns from girls than they are from boys, and teachers reprimand girls more often than boys for calling out answers during discussions. Equally problematic, teachers are more apt to call on and to listen to boys than they are to girls during discussions even though girls are more inclined to ask questions (Eccles & Blumenfeld, 1985; Monaco & Gaier, 1992; Ornstein, 1994; Sadker, Sadker, & Long, 1997). Other researchers (e.g, Barbar & Cardinale, 1991; Jones & Wheatley, 1990) have found how patterns of teacher-student interactions favoring boys are more pronounced in science and mathematics classes than they are in language arts classes.

These inequalities explain to some extent why girls become less positive about science as they advance in age (Reid, 2000; Weinbaugh, 1995a). Although research has shown that girls perform as well as boys in the sciences, academi-

cally successful females interested in science often perceive themselves as less capable science students than their male counterparts (Andre, Whigham, Hendrickson, & Chambers, 1999; Tai & Sadler, 2001). For example, Brainard and Carlin (1998) conducted a six-year longitudinal study of persistence in undergraduate women enrolled in engineering and science programs. The researchers found women performed well in these disciplines, and there was little difference in grade point averages between those women who stayed in their respective programs and those who left engineering and science programs. Instead, a lack of a supportive educational environment for women in engineering and science programs and ineffective pedagogical practices were the primary factors contributing to the attrition of women, and women reported a loss of confidence in their abilities during their undergraduate programs even though they performed well academically.

Research also has shown how women who remain in engineering programs typically have lower self-efficacy perceptions than do their male counterparts (Zeldin, Britner, & Pajares, 2008). Self-efficacy, which according to Bandura (2000) is one's judgment about one's ability to perform well in a given endeavor, is a key factor determining whether a person will attempt and persist through the completion of an academic task. In fact, self-efficacy beliefs are often stronger indicators of academic success than innate ability (Bandura, 2000; Schunk, 2004), and recent research has shown how students' self-efficacy perceptions are important predictors of academic success in engineering programs (Vogt, Hocevar, & Hagedorn, 2007).

According to Bandura (1997), people primarily form self-efficacy perceptions through their interpretations of past performances, which he termed mastery experiences. When individuals successfully complete a given task, their self-efficacy perceptions are strengthened. Consequently, they become more willing to persist through difficult academic tasks in the future because they believe their persistence will result in favorable outcomes. Conversely, perceived experiences of failure undermine people's self-efficacy perceptions and decrease their willingness to persist when academic work becomes difficult. Because rigorous academic programs like engineering require concentrated effort and persistence, it is especially important for students to develop strong self-efficacy perceptions at the beginning of their academic programs.

In addition to mastery experiences, self-efficacy perceptions are influenced by vicarious experiences, social persuasions, and physiological indexes (Bandura, 2000). Vicarious persuasions are formed when people observe the successes or failures of others who seem to have similar abilities as themselves. If students observe how peers from similar backgrounds either succeed or fail in a given academic program, they often believe they, too, would perform at the same levels if enrolled in those respective courses. Unfortunately, high attrition rates of women in engineering programs may discourage capable women from entering engineering (Adelman, 1998; Vogt et al., 2007).

Similarly, social or verbal persuasions impact people's self-efficacy perceptions in various ways and involve complex interactions of affect and cognition. For example, students' self-efficacy perceptions are strengthened when individuals such as engineering professors validate the quality of their work, but are undermined to some degree when professors question their competency. Unfortunately, research has shown how women in male-dominated fields such as engineering are more susceptible to negative verbal persuasions than are men (Zeldin & Pajares, 2000), and negative socio-cultural experiences often undermine the self-efficacy perceptions of even the most capable women (Hartman &Hartman, 2006).

THE PURPOSE OF THIS STUDY

As previously noted, women have lower self-efficacy perceptions in mathematics, science, and engineering than do their male peers. Consequently, it is not surprising that only 20% of the engineers in the United States are women even though the achievement levels of girls and young women in mathematics and science equal those of boys and young men, and in the United States and many other nations women are leaving the engineering profession at much higher rates than men are (Gill, Sharp, Mills, & Franzway, 2008). According to Blickenstaff (2005), socialization processes into the engineering profession were designed historically by men for male engineers.

Therefore, it is important to investigate whether or not socialization processes into the engineering profession differ for males and females, especially in terms of how socio-cultural experiences of males and females affect their self-efficacy perceptions and views of the engineering profession in general. A careful examination of male and female

engineering students' perceptions of their academic work and socialization processes into engineering would encourage further study on how to assist engineering students to improve retention rates, especially those of women, who, as reported by Hartman and Hartman (2006), often experience a decline of self-confidence in their science, mathematics, and engineering programs even when they have excelled academically.

METHODS AND PROCEDURES

This qualitative study was designed to elicit undergraduate students' perspectives about their experiences in engineering programs. As noted by Patton (2002), qualitative research investigates complex, multifaceted realities of social interactions as a person attempts to interpret and make sense of personal experiences. From a phenomenological perspective, one's experiences and interpretations of those respective experiences are important aspects of how one understands one's inner reality (Merleau-Ponty, 1964), and the primary focus of this study was to capture the inner views of participants' lived experiences to understand the commonalities and differences between the socio-cultural experiences of male and female engineering students. As advocated by Strauss and Corbin (1990), a grounded theory approach was employed to provide participants with opportunities to voice their interpretations of social interactions within their respective engineering programs.

Participants

Our sample consisted of 55 undergraduate engineering students (juniors and seniors), who volunteered to participate in this study. Thirty-three of the participants (17 women and 16 men) were enrolled in an engineering program at a Division I research university, and 21 students (11 women and 11 men) were from a Division II teaching university. Both the Division I and Division II universities are located in the American Southwest. We have not revealed the names of engineering students or their respective university programs because several Division I students stated they would not answer questions candidly if they and their engineering programs were identified. Consequently, we assured participants we would not reveal names of students or universities.

Data Collection

A protocol of open-ended questions was designed to allow engineering students opportunities to discuss their experiences in detail to capture the complexities of their interpretations of memorable events. When we initially administered the open-ended questionnaires, we gave students as much time as necessary to voice their views in sufficient detail. Two weeks later, we returned students' initial responses and provided them another opportunity to expand on their previous responses or to discuss other important issues, and students were given as much time as they deemed necessary to complete their second responses.

Data Analysis

Qualitative methods as advocated by Strauss and Corbin (1990) were employed to identify salient themes for categorization into units of analysis. Careful attention focused on themes in which similarities and differences in the experiences of males and females emerged. An understanding of multiple perspectives is a critical component of any phenomenon studied in that both common and dissenting voices often serve as significant counterpoints to identify seminal themes and to understand their complexities (Creswell, 1998).

Two researchers coded the data, and differences in coding patterns were referred to a third researcher, who also coded the given items in question. In most cases, the third coder resolved discrepancies between the two primary coders; however, any unresolved discrepancies in codlings by the third coder resulted in the elimination of the disputed item. Next, a componential analysis was prepared to delineate and summarize patterns of coded themes, and two additional colleagues familiar with qualitative analyses were asked to comment on selected themes and their respective patterns to strengthen the internal validity of this study (Merriam, 1988).

RESULTS AND DISCUSSION

Academic Stress

The most common theme mentioned by both Division I (9 males and 14 females) and Division II (6 males and 10

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females) students concerned academic stress. The intense workloads and fast-paced curriculum typical of any engineering program apparently challenged and required students to study long hours to complete their rigorous academic work. Most male and female engineering students mentioned how studying for examinations and completing projects demanded most of their time, and they had few free moments for relaxation. Nevertheless, the majority of those engineering students (7 male and 8 female Division I students and 6 male and 8 female Division II students) who discussed the stressful nature of engineering programs also noted their satisfaction with engineering as a program of study. For instance, one male Division I student noted:

> The past few years as an engineering student have been stressful and consisted of making many sacrifices and spending countless hours on homework and projects to meet unreasonable deadlines in most cases. However, as hard as it was, I am thankful for the problem-solving skills and the work ethic I got out of it. If I had to do it again, I would pursue engineering.

Other engineering students from both universities reported that the challenges, stresses, and intense workloads did not undermine their enthusiasm for their respective engineering programs. One reflective female Division II student noted that persevering through the difficulties of her engineering program helped her to develop more self-confidence:

> The engineering program is often stressful- more than I would have expected. The challenges often test my faith in myself, but I always learn how to work through it and am a stronger person now.

In cases like these, it seems students' mastery experiences resulted in the positive development of their self-efficacy beliefs, which are a source of internal encouragement and confidence when they perform difficult academic tasks.

On the other hand, some students (2 male and 6 female Division I students and 1 male and 2 female Division II students) referred to the stress of their workloads in pejorative terms. Typical comments focused on students' perceptions that the amount of work expected from engineering students is unreasonable as represented by the following comment from a male Division I student:

> The harsh & fast pace of the program is made unnecessarily stressful by unnecessary assignments- especially when we [engineering students] are not really sure what professors expect from us.

Such comments seem to imply that professors could have mitigated some academic stress and confusion about assignments if they had clarified their expectations for academic tasks. Perhaps these same students would have accepted the challenges of their respective engineering programs more willingly if they had been more aware of how to focus their efforts to complete academic tasks. Clear expectations and guidelines for academic tasks are essential aspects of effective pedagogy in that they scaffold instruction and guide students through the successful completion of academic work (Moll, 1990; Vygotsky, 1997a), which often strengthens their self-efficacy perceptions (Lent, Brown, & Gore, 1997).

Concern for Students

Another frequently mentioned theme common to both Division I and Division II students concentrated on professors' concern for students. However, there is stark contrast between the commentaries of Division I (2 males and 5 females) and Division II students (1 male and 6 females). No Division I student explicitly stated professors were concerned about students, and both male and female students voiced their frustrations with professors who seemed unwilling to help students with assignments because they primarily focused on research instead of on teaching. For instance, a Division I male student noted:

> Professors do not care about teaching, only about their research, and the homework assignments do not prepare you for examinations. It seems they are indifferent to students- and they show up for class only because they have to.

Likewise, a Division I female student stated:

> Engineering professors don't care about teaching or students. They are seldom there for office hours. Research,

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research, research is what really matters to them- not teaching.

Conversely, typical comments from Division II engineering students (1 male and 6 females) emphasized how professors made active efforts to assist students. For example, one female student noted: "Professors are caring and do their best to help you understand everything to the fullest." Likewise, another female student stated, "Professors are very accepting and welcoming, and the professors here are great." Even when Division II students emphasized the difficulties of their program, they still mentioned that professors were willing to help with their academic work as representative of a comment from a male student:

> The deadlines for projects and the projects themselves are not always reasonable, but I can say my professors are willing to help me and other students. This makes a huge difference in my attitude about the program.

Also, both male and female Division II students reported that professors were available during their office hours to answer questions about assignments. Consequently, it is not surprising that Division II students expressed more satisfaction and less frustration with their respective engineering programs than did their Division I counterparts.

Working on Group Projects

Like the concern for students theme, Division I and Division II students differed in their commentaries about working on required group projects. In terms of Division I students (3 males and 11 females) who mentioned working on group projects, all men referred to working in groups as positive learning experiences, while only 4 of the 11 women reported positive experiences. In contrast, of the 8 Division II students (2 males and 6 females) who discussed work group activities, all engineering students except 1 woman referred to working on group projects as a positive experience.

Positive Experiences When Working in Groups

Students who viewed group projects in positive terms, whether they were male/female or Division I/Division II students, typically noted how working closely with peers enhanced their academic work, improved their work ethic and communication skills, and provided opportunities for personal development. For example, one female Division II student stated:

> I have always had a strong work ethic, but working in the learning community groups stretched my work ethic as it does when I'm on an athletic team. I always try to do my best but having other people depending on you makes you push yourself even more. At this point I know my work ethic and confidence in myself is stronger as a result of this program and my group. I learned a great deal from the others.

Some students even noted how working in groups on engineering projects was their first positive experience with group work as representative of the following comment by a Division II female student:

> I'm sorry to say I never had this type of experience working in groups before. In the past it always seemed like I had the double duty of carrying myself and my group, but this was a good team and team building experience.

These findings are similar to those of studies on cooperative learning in that students often work more conscientiously when completing a common group goal because each student is required to complete a given component of an assignment for the group to succeed (Johnson & Johnson, 1999; Slavin, 1996b).

Equally important, several male and female engineering students from the Division I and Division II universities emphasized how they benefited from the moral support and encouragement of their respective work groups. As representative of the following response from a Division I female student, students noted how effective work groups helped to ameliorate the stress of their intense workloads:

> I cannot say it was all bad, but it would have been without my group that supported and encouraged me. As hard as the engineering program was, I am thankful for the support from my work group and problem-solving skills I got out of it.

Since engineers often work in teams, these positive experiences in completing group projects and meeting deadlines provide engineering students opportunities to develop the type of interpersonal skills necessary for working in the

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engineering profession.

Another reported benefit of work groups concentrated on the development of friendships in addition to positive professional relationships. Such friendships seemed especially important for those students whose family members live at a distance from their respective university, as one female Division II student noted:

> Making connections and developing friendships in my work group is one benefit of being in an engineering program, and these friendships make the engineering program much better, especially since my family is not within even a day's drive, so I don't see them until the end of each semester.

Positive interactions among group members seemed to provide some students an important support structure, which improves student retention (Veenstra, Dey, & Herrin, 2009).

Negative Experiences When Working in Groups

Although some male and female students reported positive experiences while working on group projects, several female engineering students voiced their frustrations about what they perceived as unequal treatment and different expectations for male and female students. However, in regard to inequities between the genders, only one female engineering student from the Division II University voiced her frustrations, in contrast to 7 of the 11 female Division I students who commented about working on group projects. The Division II female student expressed her concerns about having "to prove herself as a female who is competent, intelligent, and equal to the men" in her classes, and she emphasized:

> There is definitely an amount of exclusions toward women, whether it's intentional or not. It's harder for me as a woman to prove I'm just as experienced and competent as everyone else. I just want everyone (including me) to be treated equally.

Her commentary about whether or not the exclusion of women is intentional voices an important concern for women in the male dominated profession of engineering. She understands the culture of engineering is historically male-oriented, and she realizes incidents of the inequitable exclusion of female engineering students by their male counterparts may not be intentional acts or recognized as inequalities by male students.

It is not unusual for people to accept various cultural norms without thinking about their underlying assumptions or their intended and unintended consequences (Nieto, 2004). Nevertheless, exclusion is still exclusion whether it is intentional or not, and the results of exclusion are still the same regardless of the circumstances causing such inequities. The female Division II student does not seem to perceive a polarized situation of women vs. men. Instead, she, as a female engineering student, wants to be equal to "everyone"- that is, equal to but not considered better than male students.

In terms of voicing concerns about gender bias, the criticisms of Division I female students were more emphatic than those of the Division II female student. As noted by several Division I female students, some male students attempted to reduce the roles of female students to that of passive observers, and one Division I female student stated:

> Sometimes I wish the guys would let me do the experiments. They push the girls back and tell us to take notes. When we have opportunity to do so, we [women] work in the same group so we can actually do it. I don't think they [men] do it [exclude the female students] on purpose, but they still do it.

Similarly, other Division I women reported being upset by negative sociocultural comments from their male counterparts. For example, one woman was told, "Your job is to make coffee. We don't want your help." Another Division I female student woman stated she disliked being expected to perform secretarial duties when she was the only female in a work group:

> I resent being expected to type every report for my group just because I'm the only girl in the group. This creates a lot of extra work and stress for me, and I did not enter engineering to be my group's personal secretary. I entered engineering to be an engineer.

Some Division I female students also expressed their frustrations when discussing incidents about how their male counterparts made inappropriate sexual related comments during group work on projects. For instance, one woman

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stated, "They [male engineering students] also made sexual jokes and used me as a reference. I was completely humiliated." Likewise, another Division I woman reported:

> My team had six members, and I was the only female. During one meeting while we were brainstorming ideas, my group got off topic and began discussing Halloween costumes. I remained quiet, but two group members began saying that I should dress up as a Playboy Bunny. When I got upset and told them we should get back to the project ideas, they told me to go make coffee.

Unfortunately, these types of gender bias and discrimination have been documented by other researchers (Sonnert & Shelby, 1999; Vogt et al., 2007).

Consequently, it is not surprising that seven Division I female students reported they prefer to work with women than they do with men. For instance, one woman stated, "In programs like this where women are considered second class, it's much better to work in a group of women." Similarly, another female engineering student simply emphasized:

> Women need women—period—to build each other up. There are always a few men who try to tear us down.

As previously noted, both men and women commented that the academic demands of engineering programs created high levels of stress, and if women also have to deal with negative sociocultural interactions in male-dominated work groups, it is understandable why some women prefer to work in groups with other women as a means of support and a way to avoid additional stress caused by negative group dynamics.

Biased Professors

Another salient theme concerned derogatory comments from professors. No men from either Division I or Division II programs and no women from the Division II program voiced concerns about negative comments from professors. However, seven Division I women reported that a few professors voiced pejorative commentaries about women in engineering. For instance, one Division I female student stated:

> I'm tired of professors who think girls are second class citizens. They make comments indicating we do not belong in the field. This indicates to the boys to do the same thing. Without other girls in the program, I wouldn't make it. We help each other.

Likewise, another Division I woman voiced her chagrin when male professors subjected female students to disparagement:

> Most of the male professors are good but some don't want girls in the program and do their best to make you feel like a piece of meat. They try to tear down our confidence while other girls build us up again when this happens. It's a matter of survival!

In lieu of the these aforementioned comments by female Division I students, it is not surprising that a Division I student noted that she "was much better off during her second year of courses [than she was during her first year]" because she "had better professors who didn't egg it on to seemingly tell the boys in the class it's OK to make insulting comments about the girls."

If female engineering students have to deal with derogatory gender-biased verbal persuasions from male professors in addition to coping with the demands of their academic work, it is understandable why many capable women leave engineering and why women rely on other women for support to mitigate derogatory sociocultural persuasions, which sometimes undermine a person's self-efficacy perceptions (Blickenstaff, 2005; Parjares, 2005).

Gender Bias during Job Fairs

Three women (1 Division II and 2 Division I students) also reported experiencing unpleasant comments from male recruiters when interviewing at job fairs. One female student noted she was rejected as a viable candidate for an engineering firm because the recruiter considered her an attractive woman:

> I was told at a job fair interview last week that I was too pretty to work for the company because the men would be flirting with me instead of working. He said he couldn't afford to pay guys to be distracted by me. In 2009! How disgusting!

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Similarly, another female student noted how another recruiter was more concerned about her appearance than her qualifications to work for an engineering firm:

> At the last job fair, I talked to a recruiter whose only comment was, "You are so beautiful. You look nice in that dress." You know, I worked so hard to get where I am and just want to be treated like I know something. I have better grades than anyone and yet, I can't seem to be taken seriously when applying for engineering jobs. I wish for once, I could be treated like everyone else.

The female students who made the aforementioned comments about their experiences at job fairs have not asked for special treatment, only for equality as mandated by federal hiring guidelines. These incidents of discrimination may or may not be common occurrences; nevertheless, they raise concerns about hiring practices of engineering firms. If women who graduate from engineering programs are denied employment or are discouraged from applying for engineering jobs because recruiters consider them attractive, then fewer women will enter the engineering profession, thereby continuing the shortage of female role models in engineering.

Resiliency and Familial Support

Another prevalent theme reported by female engineering students concerns familial support. Several women (6 Division I and 4 Division II students) noted that female family members encouraged them to excel in mathematics during their elementary, middle school, and high school years of schooling. For instance, one female Division I student commented:

> My mother encouraged me throughout my life at whatever I studied—and she especially helped me to excel at math. Without her encouragement I do not think I could have succeeded. My mother is the positive role model I look to in my life.

In the case of this student and that of others, her mother's positive verbal persuasions became a source of emotional support and encouragement for her to excel in mathematics and engineering. Her mother's support seems to have affected the development of her strong self-efficacy perceptions, which may have provided her with the resiliency to persevere through her engineering program.

Some female students who emphasized how maternal support positively impacted their lives also noted how their sisters or father encouraged them. One Division II woman stated:

> My mom and dad have been great—they are always there for me. My sisters are supportive and helpful also. I am so fortunate to have the support of everyone—and I go home as often as possible to reenergize myself emotionally. I don't know how I would make it through the program without my family behind me.

As noted by various researchers (Bandura, 2000; Eccles, 1992; Zeldin & Pajares, 2000), significant individuals in a person's life, such as parents, counselors, teachers, and coaches, profoundly affect an individual's self-efficacy perceptions. Consequently, it is not surprising that some female engineering students reported how they need support and affirmation from women (e.g., mothers, grandmothers, sisters) to reassure them that engineering is a viable career choice for female students even though it deviates from stereotypical career choices such as nursing or teaching.

In contrast, no male Division I or Division II engineering students mentioned anything about how family support influenced their respective career decisions. This does not imply that no men were influenced by family members; this seems highly unlikely especially in consideration of research on the positive effects of parental involvement on academic achievement for both males and females (Comer, Haynes, Joyner, & Ben-Avie, 1996; Epstein & Sanders, 2000). A more plausible explanation is that men are more accepted in male-dominated fields such as engineering than are women; consequently, men are less inclined to seek support outside of their engineering programs for positive social persuasions and encouragement. Also, since most engineering professors are men, male engineering students may have more role models and mentors to assist them in socialization processes into the engineering profession.

Lack of Background Knowledge

Another reported difficulty experienced by 5 Division I and 4 Division II female students but by no male engineering students concerned the lack of background knowledge of everyday mechanical applications. Some female engineer-

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ing students mentioned that test items often concentrated on concepts not discussed in class as representative of the following comment of a Division II student:

> It's hard to succeed in classes when tests ask questions about things related to how cars, pumps, and machines work, but yet these things are not discussed in class. My dad has helped me a lot explaining these things to me. The problem is when they are used as examples on tests and I've never been taught about these things. The guys all seem to know about these things because they learned about them growing up….

During their formative years of growing up, some female engineering students seem to have been socialized into stereotypical gender roles in which men work on cars and women perform household chores. Consequently, some female students lack important background knowledge about various mechanical functions common to most male engineering students, and they must learn about theoretical concepts emphasized by engineering professors while also struggling to understand the significance of their professors' references to car engines and various machines.

CONCLUSION

The experiences of male and female engineering students are similar in some respects, although they differ in significant ways. Both men and women noted that their respective engineering programs were challenging academically and, at times, stressful, and a number of male and female students reported that they benefited from working in groups to complete projects. On the other hand, some women—especially those from the Division I university—reported that men expected them to accept secretarial roles, such as making coffee and typing reports for their groups, and in these types of cases it seems as if female engineers were expected to resign themselves to the roles of a paraprofessionals instead of trained engineers. In some respects, the expectations of women to take on secondary roles while working on hands-on engineering projects is similar to behavior patterns found in many middle and high school science classes in that females typically are excluded from taking active roles in projects and often are expected to take notes for their respective groups while males handle the laboratory equipment (Sleeter and Grant, 2009). Consequently, it is not surprising that some female engineering students preferred to work with other women and that they needed support from female colleagues and the family members to ameliorate the effects of negative verbal persuasions and to strengthen their self-efficacy perceptions.

Some Division I female students noted that a few male professors do not want women in engineering. Conversely, the Division II women were provided much more support from male peers and professors, and they noted that professors were concerned about students' academic success. The primary mission of this Division II university is and has always been teaching, instead of research, and the professors apparently provided more encouragement for female students, who experienced fewer difficulties in socialization processes than did female students from the Division I university. The small sample of this study prevents us from generalizing these findings to other Division I and Division II engineering programs; however, the negative sociocultural experiences reported by Division I females while working in collaborative groups raises questions about the social interactions of these respective work groups.

Although recent research findings (e.g., Stump, Hilpert, Husman, Chung, & Kim, 2011; Vogt et al., 2007) have shown that collaborative work groups increase student learning, there is a paucity of research in terms of detailed analyzes on how effective work groups actually interact as they complete assigned projects. Consequently, more research on collaborative work groups is needed to set guidelines for social interactions, to create models of efficacious team building, to improve instruction, and to increase the retention of female engineering students. Because engineers collaborate in teams in the work place, the development of efficacious social skills is an important part of socialization processes for both male and female students and should be emphasized more overtly in engineering programs (Veenstra et al., 2009).

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