The Influence of Gender Stereotypes on Role Adoption in Student Teams

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Abstract

Educational research provides ample evidence of the benefits of effective group work for engineering students including improved material retention, development of higher-order cognitive skills, and higher performance[1]. This work also describes best practices in the creation of effective student teams including suggestions for team size, the placement of students in teams, and student diversity. While diversity in this context includes a broad range of considerations spanning abilities and perspectives, Tonso[2] suggests that teams should include racial and ethnic diversity specifically, whenever possible. However, research has shown that despite best practices, women or minorities on teams can experience negative outcomes. Their perspectives are not always considered valid by majority teammates, and they are often assigned unimportant tasks[3, 4], reflecting a societal stereotype of majority men as engineering "experts." Moreover, under-representation of one's social group (e.g., gender or race) in the academic environment can lead to reduced performance as a result of stereotype threat, i.e. the concern that poor performance may appear stereotype-confirming to others[5, 6, 7]. The isolation that these students feel on their teams may lead to diminished feelings of belonging in their field and lower retention among these individuals[8].

Despite the employment of best practices, our earlier analysis of approximately 600 undergraduates involved in group oral presentations reveals that women on first-year engineering project teams exhibit less active participation than men, and that this happens regardless of the representation of women on the team. Men are disproportionately more likely to present the technical content in oral presentations than women, to speak longer than expected and longer than women, and to field more audience questions than women[9, 10]. In addition, students' self-reported learning from the project is positively correlated with taking on active presentation roles, roles primarily adopted by men.

This paper provides a summary of the statistical findings of adding an additional 500 first year student participants to the prior work, lending further validity to our initial findings. To complement these quantitative results, we also describe the results of a focus group study, involving students who were enrolled in the targeted engineering course in a prior term. Themes emerging from the focus groups highlight the presence of gender stereotypic role adoption. Although students in general felt that teams strive for fairness in determining roles, those roles were recognizably aligned along stereotypical lines. Despite this recognition students thought this phenomenon was mostly self-determined, and that they were not pressured into it. Stereotyping was evidenced in reports of women most often taking on organizational roles, taking notes, scheduling meetings, and distributing agendas. Of interest, women saw these non-technical roles as less desirable because these are seen by others as insubstantial, but these were the very roles that women were most often taking on. Thus, we were able to document that gender stereotypes influenced the roles adopted by men and women in their group project presentations and that students, while recognizing the stereotypical patterns of behavior, do not recognize the influence that conforming to these patterns has on their educational outcomes.

Introduction and Background

Research from engineering education and social science provides a synergistic foundation for predictions about the effect of gender stereotypes on the participation of male and female students in engineering project groups.

Recent trends in engineering enrollment and persistence. Enrollment trends in engineering schools in the US show increased numbers of students entering the engineering field over the past decade[11]. Enrollment of female students has been rising, reaching 18.6 percent in 2010; however, women remain greatly under-represented in the field. Likewise, enrollments of some groups of minority students remain very low. African American enrollment has declined to only 5.9 percent of undergraduate engineering enrollment. Hispanic student enrollments, although increasing, remain low at approximately 9.1 percent. At the University of Michigan College of Engineering, enrollment of female students has been relatively high, reaching its peak at just over 30 percent in 2002, but has recently declined despite increasing national trends, settling at about 25 percent. Under-represented minority (URM) student enrollment in engineering at Michigan has also declined since reaching a high in 2001 of approximately 15 percent.

While enrollment in engineering is increasing, the field is faced with high attrition rates. Since 1975, nationwide engineering student attrition has increased, doubling from about 12 percent to 24 percent in 1990[12], and reaching as high as 40 to 60 percent in the last decade[13]. This trend exacts a significant cost on the institution and the individual. Research across gender and race cohorts shows that each group reports different reasons for leaving engineering. Students who leave often exhibit a lack of motivation[14] and self-efficacy[15, 16]. Women may lack in the development of professional role confidence[17], and URM students sometimes report additional complex and unique situations, including financial challenges and specific experiences in the instructional settings with other students and faculty that lead to attrition from the field[18].

Overall, enrollment trends in engineering indicate that women and minority students continue to be highly under-represented in the field, with higher attrition when they do enroll, for reasons that are associated with their experiences on campus. With the growing importance of group work in the engineering educational setting, and the persistent stereotyping of the field as a majority male domain, negative intergroup experiences in this setting may contribute significantly to the perceptions and intentions of under-represented students.

The group work environment in engineering education. Educational research provides ample evidence of the benefits of effective group work to students including improved material retention, development of higher-order cognitive skills, and higher performance[1]. This work also describes strong frameworks and best practices in the creation of effective student teams including team size, student diversity and the determination of team membership. For example, teams consisting of three to five individuals facilitate individual accountability, allow for less complex out-of-class meeting time management and provide a sufficiently broad set of perspectives and resources[19, 20]. Best practices also suggest not isolating under-represented students on teams, especially in fields such as engineering where there are fewer under-represented students and where academic networks are not sufficiently robust to support the needs of these students. To create heterogeneous teams and control resource distribution among

teams, it is necessary for instructors to actively assign team membership, seeking balance in terms of race, gender and ability[21].

Although heterogeneous teams can encounter more challenges as diverse participants learn to work together, such teams allow students to share diverse perspectives and skills and typically result in more effective performance than homogeneous teams[19, 22]. While diversity in this context includes a broad range of considerations spanning abilities and perspectives[21, 23, 24, 25, 26], Tonso[2] suggests that teams should include racial and ethnic diversity specifically, whenever possible. However, research has shown that isolating women or minorities on teams can negatively impact their participation in significant ways. Their perspectives are not always considered valid by majority teammates, and they are often assigned unimportant tasks[3, 4]. Also, under-representation of one's social group (e.g., gender or race) in the academic environment can raise concerns among women and minorities that poor performance may appear stereotype-confirming to others[27, 6, 7]. The isolation that these students feel on their teams may lead to a lower feeling of belonging in their field and lower retention among these individuals[8]. These processes have been examined in social science research in the areas of stereotype threat, gender differences in small group dynamics, and active learning.

Stereotype Threat. A large body of social science research has demonstrated that gender stereotypes exist purporting than men have more ability than women in math and science fields, including engineering. Laboratory studies on the topic of *stereotype threat* have demonstrated the significant detrimental effect of these stereotypes on women's performance in math and science fields, and on their intention and motivation to pursue math and science-related education and careers[5]. For example, in lab studies women score lower than men on a math test when cues in the setting raise awareness of the gender stereotype[28, 29]. This phenomenon was also observed for performance on an engineering exam[30]. This low performance of women is said to occur because awareness of the stereotype leads women to worry that a poor performance would appear stereotype-confirming to others, and the threat of appearing stereotypic raises stress and distracts them from concentrating fully on the test. Of importance, such studies also show that women's math and engineering performance outcomes can match that of men's when instructions are given that minimize the relevance of gender stereotypes in the testing situation, e.g., by describing the test items as non-diagnostic of inherent ability. This indicates that women have aptitude similar to men, but that expression of this aptitude is impeded by the stereotype. Further research has demonstrated that experiencing stereotype threat also leads women to disidentify from math and science fields, to develop more negative attitudes about these fields, and lowers their intention and motivation to participate and persist in these fields[31, 32]. Thus, despite equal aptitude, women's participation, persistence, and performance in engineering, and in engineering group project teams, can be diminished by the awareness of gender stereotypes purporting their lack of ability compared to men.

Gender differences in small group dynamics. Across many studies of small group discussion, men have been shown to talk more and more assertively, to talk longer, and to be more likely to emerge as leaders compared to women[33, 34]. This gender difference in participation in small group discussion emerges more strongly among undergraduates (compared to older adults) and among those less familiar with one another, both characteristics of undergraduate engineering group project teams. Men's dominance is more pronounced in mixed gender groups (as

individual men tend to dominate more in the presence of women than with other men), and when the group is engaged in male-typed tasks. Male-typed tasks are characterized as being non-personal and instrumental (focused on accomplishing a goal), as compared to female-typed tasks, characterized as interpersonal and relational[35]. When the group's task is in a gender neutral or female-typed domain, the gender difference disappears or even reverses, with women engaging in more assertive speech and emerging as leaders in mixed gender group discussion, e.g. regarding childcare[36]. Thus, small group dynamics research has gone beyond demonstrating an overall gender difference in participation in small groups, uncovering moderators of this effect and documenting the features of a group task situation in which women's participation matches or even exceeds that of men's. This body of research suggests that gender differences in stereotypic role adoption may be most likely to emerge in male-typed vs. female-typed academic domains.

<u>Active learning</u>. The noted gender differences in small group participation is important in light of research evidence showing that *active learning* in educational activities enhances learning[37]. An active learning environment is one in which the student is actively participating in the learning process through in-class and out-of-class exercises that can vary in duration from a few moments to an entire semester. This work demonstrates that learning and understanding is optimized by taking an active role in collaborative or cooperative learning settings. However, the presence of gender bias on teams has been shown to diminish the effectiveness of active participation[38], resulting in fewer opportunities to develop self-confidence and a sense of self-efficacy in the field. Self-efficacy is defined by social science researchers as an individual's judgment of his or her own abilities to accomplish a specific task or objective[39]. Research in the STEM fields suggests that students with high self-efficacy show greater cognitive engagement in related tasks[40], and set more challenging goals with stronger commitment. In addition, research reveals that men achieve higher levels of self-efficacy in STEM than women[41, 42], and that this persists despite lower academic gaps between men and women[43]. The self-efficacy gap has been found to be partly responsible for the lower number of women pursuing careers in the STEM fields[44].

It is important to note that recent qualitative investigations of the influence of first-year engineering student experience on student beliefs in self-efficacy show that students repeatedly evaluate their success by assessing performance comparisons with their peers[45]. This use of vicarious experiences in the development of self-efficacy is particularly important for people who have little or no prior personal experience upon which to draw, characteristic of first year engineering students. In particular, many of these comparisons are made regarding the nature and extent of group work contributions, in addition to performance speed, amount of material mastered, and grades. In the situation in which women are less likely to have the personal experience or see another woman experiencing success in a technical role, women may be further denied the opportunity to develop their own sense of self-efficacy.

Study Design

The study described in this paper is intended to address the general question, "Do men adopt more technical roles than women in engineering group project presentations? And, if so, what are the implications for teaching and learning?" The goal of our study was to rigorously document

the observation that women engage in less active participation than men in first year student group project presentations, and begin to explore the antecedents of this pattern of behavior. To address this goal, videotapes of first year engineering group project presentations were evaluated. Coding schemes were developed to establish reliable documentation of stereotypic gender role adoption, defined as behavioral patterns reflecting the gender stereotypes of men as engineering "experts" and women as "supporters" of male experts. In an initial pilot study of approximately 600 students, it was found that men's greater active participation than women (a result of stereotypic gender role adoption) was evidenced in men being disproportionately more likely to present the technical content in oral presentations than women, to speak longer than expected and longer than women, and to field more audience questions than women[9]. A similar, but more robust analysis was performed to improve confidence in the findings. This data set consisted of videotaped group presentations given by more than 1100 introductory engineering students at the University of Michigan College of Engineering spanning the academic years 2009 through 2011.

For the video analysis, two independent judges scored each group's presentation on the roles adopted by each student, technical vs. non-technical, the amount of time speaking, amount of time that each speaker presented as well as their perceptions of student leadership, effective speaking and apparent knowledge of the subject. Technical aspects of the presentation include the detailed description of the design solution, technical specifications, calculations, or analyses. Non-technical aspects include the title slide or final slide, introduction, implications, or summary. Inter-rater agreement between the independent judges on role categorization was confirmed by significant inter-rater reliability analyses. To complement this data, a subset of students was given a short survey immediately following delivery of their final oral presentations. The survey included five items measuring self-reported learning from the group project experience ("I would have gotten more out of the presentation if I had taken a more active role; I learned a lot on this project; I didn't get a lot out of doing the project (reverse scored); My understanding of course material was strengthened; I learned a lot by presenting it to others"). The items were rated on a 7-point scale (1-strongly disagree, 7-strongly agree), and ratings were averaged to create a composite self-perceived learning score.

To complete the data set, general data was compiled on the student participants including age, citizenship, performance indicators including ACT/SAT scores, AP credit, course grade, GPA, and self-reported gender and race-ethnicity. These three data sets (video analysis, survey and general data) were merged into a single database for analysis.

Analysis was performed examining the roles adopted by each student as a ratio of technical to non-technical slides, the number of technical (or non-technical) slides presented versus the expected number of technical (or non-technical) slides (based on the number of technical slides available to present divided by the number of group members), the speaking time ratio (actual/expected time), and self-reported learning (sub-sampled via the questionnaire). By coding group composition into three categories (male-dominated, gender-equal, female-dominated), we analyzed the data set using the ANOVA: 2(student gender) X 3 (group composition). Some analyses included role type (technical or non-technical) as a third within-subjects factor.

To complement this quantitative analysis, focus groups were conducted involving students who were enrolled in this introductory engineering course in a previous term. The focus groups were conducted by members of the University of Michigan ADVANCE program research staff. Two staff members conducted each focus group; one staff member led the discussion and the other took detailed notes. The sessions were also tape recorded and transcribed.

A total of 36 students participated in nine different focus groups. The groups were constituted separately by gender; five of the groups were all female and four were all male. The largest group consisted of five students; the smallest had two. An effort was made to ensure that none of the students in a focus group had been on the same team for their course project.

When students arrived they were asked to complete a consent form as well as a pre-focus group survey. The survey asked them about their group projects for their introductory design course, including who was in the group, who in the group seemed to be a leader and who seemed to be a follower or supporter; this allowed students an opportunity to recall their group experiences and prepare them for the group discussion. These surveys were coded for gender breakdown of the previous presentation groups. Of the 36 students who participated in the focus groups, thirteen were in all male presentation groups and one was in an all female presentation group in their introductory design course. Of those who were in mixed gender presentation groups, ten had only one woman, eight had at least two women and one had only one male in the presentation group.

The purpose of the focus group discussions was to learn what role, if any, gender played in students' participation in the group projects and their learning experiences more generally. Students were asked about their experiences with the group project, and specifically about the presentation of their project at the end of the semester. Questions were asked about the different roles assumed by students for the presentation, how those were decided and if social pressures and/or stereotyping played a role in that process, and how their presentations went. Students were also asked about the value of the group presentation process and any suggestions they had about improving the learning experience. Students appeared to enjoy the focus groups and to appreciate the opportunity to give their feedback. Most students described positive experiences with the group projects. They also appeared to be students who were highly engaged and motivated to achieve academically.

Transcripts of the focus groups were organized by question and then coded for content and themes that emerged from each question.

Results

Video and Survey Analysis Table 1 provides an overview of the full study videotaped data set. Overall, 431 female participants and 692 male participants on 246 teams were evaluated, and a total of 1123 were available for analysis. A subsample of the total (N = 215) also completed the survey questionnaire.

Table 1. Data set of videotaped participants showing team composition by participant gender.

Team Composition	Analysis Categories	Teams	Women	Men
All Women		6	26	-
Solo Man	Female	17	62	17
Two Men	Dominated	34	101	69
Gender equal	Gender Equal	40	85	85
Two Women	Male	46	90	135
Solo Woman	Dominated	68	67	237
All Men		35	-	149
Totals		**246**	**431**	**692**

The technical and non-technical slide ratio was determined by counting the number of technical or non-technical slides presented by the participant and dividing this value by the expected number of technical or non-technical slides that would have been presented if the distribution of these slides were equitable across the team members.   To determine the expected number of slides, we counted the number of technical and non-technical slides in the presentation and then divided each of these values by the number of students in the team. An analysis of the technical versus non-technical slide ratio by student gender for the three mixed gender team composition categories reveals a significant 2-way interaction by gender ($F(1,719) = 20.27$, $p < .001$, $eta^2 = .03$), but reveals no significant interaction by team composition.

As shown in Figure 1, men presented over 20% more technical slides than expected and just under 20% fewer non-technical slides than expected, while women presented over 25% fewer technical slides than expected and over 15% non-technical slides than expected. The analysis shows that this occurs independent of team gender composition, suggesting that even when best practices are employed, e.g. not isolating under-represented students on teams, there remains an inequity in the delivery of technical and non-technical material in the presentation favoring gender bias in a perceived male domain.
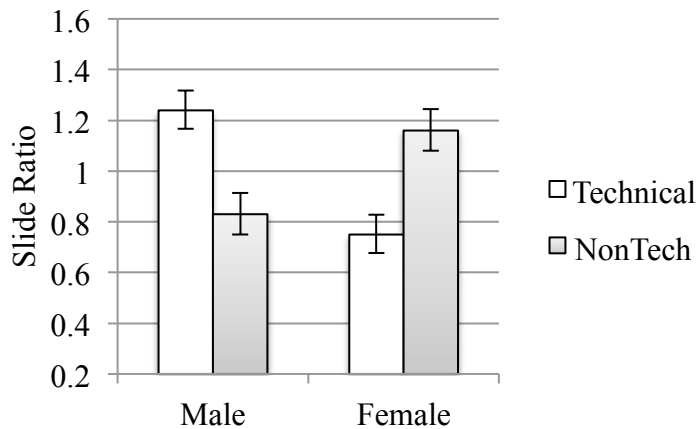

Figure 1. A significant 2-way interaction by gender ($F(1,719) = 20.27$, $p < .001$, $eta^2 = .03$) showing that men presented significantly more technical slides than expected, while women presented significantly more non-technical slides than expected.

A similar analysis was conducted for speaking time ratio, which revealed a significant main effect of gender ($F(1, 720) = 5.88$, $p = .02$, $eta^2 = .008$) in which men speak for significantly longer during the presentation than women (see Figure 2), regardless of team gender composition.
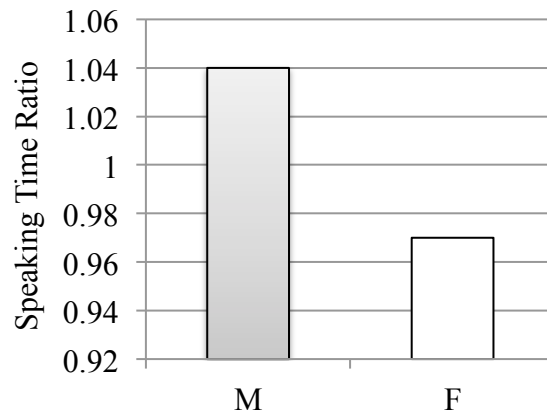

Figure 2. A significant main effect of gender ($F(1, 720) = 5.88$, $p = .02$, $eta^2 = .008$) showing that men speak significantly longer during the presentation than women.

At the conclusion of most of the presentations, the students open the floor to questions about the presentation. When this occurred, the number of questions fielded by male and female presentation group members was recorded. An analysis of the number of questions answered by men and women revealed a significant 2-way interaction with gender and group composition ($F(1, 731) = 6.66$, $p < .05$) showing that men answer more questions regardless of team composition with the number of questions answered by men increasing as the team becomes more female dominated (see Figure 3).
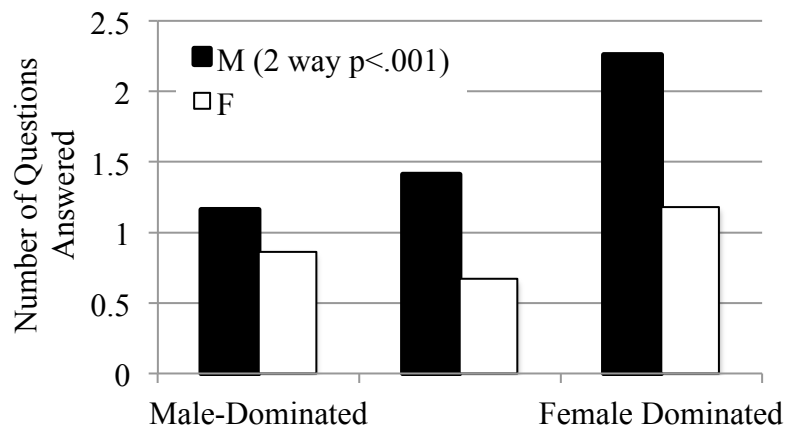

Figure 3. A significant 2-way interaction with gender and group composition ($F(1, 731) = 6.66$, $p < .05$) showing that men answer more questions regardless of team composition, with the number of questions answered by men increasing as the team becomes more female dominated.

An analysis of self-perceived learning, utilizing the sub-sample of students that participated both in the survey questionnaire and the videotaped presentation, revealed a significant correlation between technical slide ratio and an increased sense of self-perceived learning, $r(214) = .15$, $p = .03$, such that students who gave more of the technical slides reported greater self-perceived learning from the group project experience. A significant correlation also emerged between self-perceived learning and number of audience questions answered, $r(165) = .20$, $p = .01$, such that students who answered more audience questions reported greater self-perceived learning. Correlations with non-technical role ratio and speaking time ratio were not significant. Among male students, self-perceived learning was positively correlated with audience questions answered, and among female students, self-perceived learning was correlated with technical slide ratio. All correlations are presented in Table 2.

Table 2. Intercorrelations between technical and non-technical slide ratio, speaking time ratio, audience questions answered, and self-perceived learning for male and female students.

	1	2	3	4	5
1. Self-perceived learning	--	.47**	-.20	.17	.27†
2. Technical slide ratio	.06	--	-.32**	.10†	.17**
3. Non-technical slide ratio	.11	.20**	--	.08	-.04
4. Speaking time ratio	.004	.18**	-.04	--	.10
5. Audience questions answered	.18*	.14**	.07	.20**	--

†$p < .10$, *$p < .05$, **$p < .01$. *Note*. Coefficients from male students are presented below the diagonal, and coefficients from female students are presented above the diagonal.

Focus Group Analysis

Figure 4 provides a visual representation of the distribution of focus group participants by their previous ENGIN 100 team composition type.
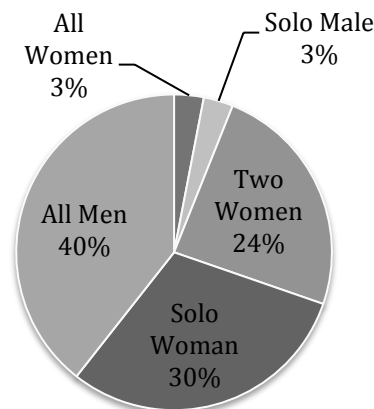

Figure 4. Focus group participant distribution by team composition type.

The focus group study provided students the opportunity to answer questions designed to assess student perceptions of their roles and participation in their final presentations as well as their sense of whether the presentation was successful, whether they experienced any social pressure or stereotyping, their perceptions of the qualities of an ideal team, the most important aspects of the project presentation, and any recommendations they have for improving the experience.

Sample discussion questions included: What are your perceptions of the kinds of roles male and female students adopt in group project presentations?; Why would they adopt these roles?; and, What are the most important parts of the presentation in your view?.

Several themes emerged from the focus groups, highlighting the prevalence of stereotyping in role adoption (excerpts below taken from the ADVANCE staff report):

- Students reported that important technical roles were given to those who were seen as experts (who were overwhelmingly male) and less important supporting roles were given to women, who more often served as organizers and note-takers. The term "secretary" came up several times. In addition, women often contributed more to the writing of the final report. As one group member commented, this was because "engineers are not good writers."

- Some women reported that men in their groups saw any women as less competent than men and therefore took over everything leaving little for the women to do.

- As suggested in the literature, teams with solo women did not perform well. One woman in an all male group even described herself as "sort of like a mom" to the men in her group, taking care of them and bringing baked goods to their meetings. One male student commented that the solo woman on his team "was quiet and did what she was told." Another described how the men picked on the solo woman in his group, but that it was all "good natured."

- Racial stereotyping surfaced as Asian American men were reported to be in charge of mathematical aspects of the project.

- While students recognized that their roles seemed to conform to stereotypes, they thought it was mostly self-determined; they said that they were not pressured into it.

- Women saw the non-technical roles (introduction and summary) as less desirable because they are seen by others as insubstantial and boring. Thus, they saw as less desirable the very roles that women were most often taking on.

- All students saw the final presentation as an important part of their learning in the course.

- Students provided suggestions for improving team dynamics and the group project experience, including having a balance of male and female students on teams, and creating racially diverse teams, and/or including members with "cultural openness." They encouraged personality assessments for team members. Finally, students suggested

that faculty should make a clear anti-discrimination statement and that faculty should devote class time to cultural awareness.

The focus groups provided qualitative evidence that gender (and racial) stereotypes influenced the roles adopted by men and women in their group project presentations.

These findings indicate that women are adopting stereotypical roles in group work without recognition that they are being subject to gender bias by team members. In support of this finding, several studies on gender stereotyping in higher education suggest that many women lack the conscious awareness to recognize discrimination, even when they are the targets[46, 47, 48, 49]. Psychological research shows that people are more likely to recognize biased behavior as discrimination when it occurs to others not to oneself, as a way to maintain positive self-esteem[50]. Contemporary women students in engineering and science who are confronted with evidence to suggest stereotyping in their domain often discount this message as something that happens to others, not to oneself[51].

Women have also been shown to distance themselves from their gender identity in an effort to belong in a male-typed domain[52], suggesting that women may take specific actions to alleviate a threatened sense of belonging. Unfortunately, lowered feelings of academic belonging in a particular domain can also cause women to withdraw from that domain. Seymour[48] provides several examples of women negotiating biased gender expectations and attitudes in engineering by attempting to become neutral and invisible, processes that impair a sense of belonging in the field. It is possible that in adopting stereotypical behaviors, women are taking a specific action to increase their sense of belonging on the team to align with team member's biased expectations.

Good and colleagues[53] showed that the desire to "fade into the background and not be noticed" in math contributed to a lowered sense of belonging to math among female undergraduates, suggesting a recursive pattern of lowered sense of belonging reducing participation in engineering, and lowered participation reducing a sense of belonging in engineering. In sum, research on academic belonging suggests that women in engineering may experience a lower sense of belonging in engineering compared to men, which can contribute to their lowered participation in engineering group work. Moreover, it is likely that women concerned about not belonging may change their perceptions and/or actions in order to find a way to fulfill the need to belong.

Conclusions (so far) and Future Work

Findings of this investigation confirm classroom observations that men take on more active roles than women in first year engineering student group project presentations and indicate that this role adoption may be largely driven by gender stereotyping. While the literature suggests that creating team gender balance can improve team performance, we show that this is not enough to overcome gendered role adoption.

Of note is the reaction of women to the adoption of these roles, suggesting that women are not conscious of the biases they are encountering or the influence these biases may have on their learning. While women recognize the educational value of taking on active, technical roles in

their final presentations, they fail to recognize the implications of their tendency to take on more supportive roles. In addition, because women lack visible same-gender role models in active, technical roles in final presentations, they do not have as many opportunities as men for vicarious validation of their self-efficacy in the field.

The next phase of this study is the development and testing of strategies to reduce gender stereotypic role adoption, and balance active participation across men and women in engineering group project teams. In this phase, gender-balanced groups of four engineering students will participate in a laboratory experiment designed to reflect a truncated version of the first year course group project experience. Groups will be assigned a group project task, and will as a group generate and present a design solution. The presentation guidelines will describe four presentation roles that must be filled: A) introduction of the project and the team; B) design solution; C) design analysis; and D) summary and implications. Stereotypic gender role adoption will be measured by the degree to which women take the non-technical roles (A and D) and men take the technical roles (B and C).

Two laboratory interventions will be introduced, and each compared to a neutral control condition. Both interventions are based on highlighting counter-stereotypic gender roles, and reducing the influence of gender stereotypes in the group project, but are delivered either in the form of a short video, or in a set of written guidelines (such as might be received as part of a syllabus). The intervention(s) are predicted to increase women's active participation in the experimental group project teams compared to control. Results will determine whether the video role model or written guidelines intervention produce better results. Questionnaires will also be used to assess experiential factors (affective evaluation of and self-rated learning in the group) as well as person and group factors influencing stereotypic gender role adoption.

[1] Finelli, C.J., Inger, B., & Mesa V. (2011) Student teams in the engineering classroom and beyond: setting up students for success. CRLT Occasional Paper No. 29, University of Michigan Center for Research on Learning and Teaching, Ann Arbor, Michigan. 12 pp.
[2] Tonso, K. L. (2006). Teams that work: Campus culture, engineer identity, and social interactions. Journal of Engineering Education, 1(1), 1-13.
[3] Ingram, S., & Parker, A. (2002). Gender and modes of collaboration in an engineering classroom: A profile of two women on student teams. Journal of Business and Technical Communication, 16(1), 33-68.

[4] Michaelsen, L. K., & Sweet, M. (2008). The essential elements of team-based learning. In L. K. Michaelsen, M. Sweet, & D. X. Parmelee (Eds.), <u>Team-based learning: Small group learning's next big step</u> (pp. 7-27). New Directions for Teaching and Learning, No. 116. San Francisco, CA: Jossey-Bass.

[5] Steele, C. M., Spencer, S. J., & Aronson, J. (2002). Contending with group image: The psychology of stereotype and social identity threat. In M. Zanna (Ed.), <u>Advances in experimental social psychology</u> (Vol. 34, pp. 379–440). New York: Academic Press.

[6] Sekaquaptewa, D., & Thompson, M. (2002). The differential effects of solo status on members of high- and low-status groups. Personality and Social Psychology Bulletin, 28, 694-707.

[7] Sekaquaptewa, D., & Thompson, M. (2003). Solo status, stereotype threat and performance expectancies: Their effects on women's performance. Journal of Experimental Social Psychology, 39, 68–74.

[8] Brainard, S.G. & Carlin, L. (1998). A Six-Year Longitudinal Study of Undergraduate Women in Engineering and Science. Journal of Engineering Education. 87(4), 369-375.

[9] Meadows, L. & Sekaquaptewa, D. (2011). The effect of group gender composition on student participation and learning in undergraduate engineering project teams. Proceedings of 2011 ASEE Annual Conference, Vancouver, BC, June, Paper 2011-1319, 13 pp.

[10] Sekaquaptewa, D., & Meadows, L. (2012). Gender stereotypic roles in engineering student project presentations: Men give technical content whereas women handle introductions. Paper to be presented at the annual meeting of the Society for Experimental Social Psychology, Austin, TX.

[11] Gibbons, M.T. (2010). Engineering by the Numbers. Retrieved from: https://www.asee.org/papers-and-publications/publications/college-profiles/2010-profile-engineering-statistics.pdf in June 2012.

[12] Beaufait, F. W. (1991). An engineering curriculum for the year 2000. Journal of Engineering Education, 80, 425– 428.

[13] Suresh, R. (2006). The relationship between barrier courses and persistence in engineering. Journal of College Student Retention: Research, Theory and Practice, 8(2), 215-239.

[14] French, B. F., Immekus, J. C., & Oakes, W. C. (2005). An examination of indicators of engineering students' success and persistence. Journal of Engineering Education, 94, 419-425.

[15] Hutchison, M. A., Follman, D. K., Sumpter, M., & Bodner, G. M. (2006). Factors influencing the self-efficacy beliefs of first-year engineering students. Journal of Engineering Education, 95, 39-47.

[16] Seymour, E., and Hewitt, H., Talking about Leaving: Why Undergraduates Leave the Sciences, Boulder, Colo.,: Westview Press, 1997.

[17] Cech, E., Rubineau, B., Sibley, S., & Seron, C. (2011). Professional role confidence and gendered persistence in engineering. American Sociological Review, 76, 641-666. DOI: 10.1177/0003122411420815

[18] May, G.S. & Chubin, D.E. (2003). A retrospective on undergraduate engineering success for underrepresented minority students, Journal of Engineering Education, 91, 27-39.

[19] Birmingham, C., & McCord, M. (2004). Group process research: Implications for using learning groups. In L. K. Michaelsen, A. B. Knight, & L. D. Fink (Eds.), <u>Team-based learning: A transformative use of small groups in college teaching</u> (pp. 73-93).

[20] Johnson, D. W., Johnson, R. T., & Smith, K. A. (1998). Maximizing instruction through cooperative learning. ASEE Prism, 8(2), 24-29.

[21] Oakley, B., Felder, R. M., Brent, R., & Elhajj, I. (2004). Turning student groups into effective teams. Journal of Student Centered Learning, 2(1), 9-34.

[22] Page, S. E. (2007). <u>The difference: How the power of diversity creates better groups, firms, schools, and societies</u>. Princeton University Press: Princeton, NJ.

[23] Brewer, W., & Mendelson, M. I. (2003). Methodology and metrics for assessing team effectiveness. International Journal of Engineering Education, 19(6), 777-787.

[24] Heller, P., & Hollabaugh, M. (1992). Teaching problem solving through cooperative grouping. Part 2: Designing problems and structuring groups. American Journal of Physics, 60(7), 637-644.

[25] Hong, L., & Page, S. E. (2004). Groups of diverse problem solvers can outperform groups of high-ability problem solvers. Proceedings of the National Academy of Sciences, 101(46), 16385-16389.

[26] Wankat, P. C., & Oreovicz, F. S. (1993). Teaching engineering. New York, NY: McGraw-Hill. (Out of print, but available at https://engineering.purdue.edu/ChE/AboutUs/Publications/TeachingEng/index.html)

[27] Inzlicht, M. & Ben-Zeev, T. (2000). A threatening intellectual environment: Why females are susceptible to experiencing problem-solving deficits in the presence of males. Psychological Science, 11, 365–371.

[28] Quinn D. M., Spencer S. J. (2001). The interference of stereotype threat with women's generation of mathematical problem-solving strategies. Journal of Social Issues, 57, 55–71.

[29] Spencer, S.J., Steele, C.M. & Quinn, D.M. (1999). Stereotype Threat and Women's Math Performance. Journal of Experimental and Social Psychology, 35, 4-28.

[30] Bell, A.E., S.J. Spencer, E. Iserman & Logel, C.E.R. (2003). Stereotype Threat and Women's Performance in Engineering. Journal of Engineering Education, 92(4), 307-312.

[31] Murphy M., Steele C., & Gross J. (2007). Signaling threat: How situational cues affect women in math, science, and engineering. Psychological Science, 18, 879–885.

[32] Nosek, B. A., Banaji, M., & Greenwald, A. G. (2002). Harvesting implicit group attitudes and beliefs from a demonstration web site. Group Dynamics, 6, 101–115.

[33] Leaper, C., & Ayres, M.M. (2007). A meta-analytic review of gender variations in adults' language use: Talkativeness, affiliative speech, and assertive speech. Personality and Social Psychology Review, 11(4), 328–363.

[34] Rosser, S.V. (1998). Group work in science, engineering, and mathematics: Consequences of ingnoring gender and race. College Teaching, 46, 82-88.

[35] Eagly, A. H., & Karau. S.J. (1991). Gender and the emergence of leaders: A meta-analysis. Journal of Personality and Social Psychology, 60, 685–710.

[36] Dovidio, J. F., Ellyson, S. L., Keating, C. F., Heltman, K., & Brown, C. E. (1988). The relationship of social power to visual displays of dominance between men and women. Journal of Personality and Social Psychology, 54(2), 233–242.

[37] Prince, M. (2004). Does active learning work? A review of the research. Journal of Engineering Education, 93(3), 223-231.

[38] Tonso, K.L., Miller, R.L. & Olds, B.M. (1994). Student learning and gender issues in a nontraditional engineering class: Implications for engineering education. Proceedings of the 1994 American Society of Engineering Education Annual Conference.

[39] Bandura, A. (1986) *Social foundations of thought and action*. Englewood Cliffs, NJ: Prentice Hall.

[40] Pintrich, P. R. (2003). A motivational science perspective on the role of student motivation in learning and teaching contexts. Journal of Educational Psychology, 95, 667–686.

[41] American Association of University Women (AAUW) (1991). Shortchanging girls, shortchanging America: Executive summary. Washington, DC: Author.

[42] Schunk, D. H., & Pajares, F. (2000). The development of academic self-efficacy. In A. Wigfield & J. S. Eccles (Eds.), Development of achievement motivation: A volume in the educational psychology series (pp. 15–31). San Diego, CA: Academic Press.

[43] Watt, H. M. G. (2006). The role of motivation in gendered educational and occupational trajectories related to math. Educational Research and Evaluation, 12, 305–322.

[44] American Association of University Women (AAUW) (2008). Women and girls in STEM. Washington, DC: Author.

[45] Hutchison-Green, M.A., Follman, D.K., & Bodner, G.M. (2008). Providing a voice: qualitative investigation of the impact of a first-year engineering experience on students' efficacy beliefs. Journal of Engineering Education, 97, 177-190.

[46] Anderson, V. (1994). How engineering education shortchanges women. Journal of Women and Minorities in Science and Engineering, 1, 99-121.

[47] Bergvall, V. (1996). Constructing and enacting gender through discourse: Negotiating multiple roles as female engineering students, in Rethinking language and gender research: Theory and practice, V. Bergvall, Editor, Longman: NY. p. 173-201.

[48] Seymour, E. (1995). The loss of women from science, mathematics and engineering undergraduate majors: An explanatory account. Science Education, 79, 437-473.

[49] Tonso, K.L. (1995). Engineering gender-gendered engineering. Journal of Women and Minorities in Science and Engineering, 5, 365-405.

[50] Taylor, D. M., Wright, S. C., Moghaddam, F. M., & Lalonde, R. N. (1990). The personal/group discrimination discrepancy: Perceiving my group, but not myself, to be a target for discrimination. Personality and Social Psychology Bulletin, 16, 254-262.

[51] Wright, S. C., & Taylor, D. M. (2003). The social psychology of cultural diversity: Social stereotyping, prejudice and discrimination. In M. A. Hogg & J. Cooper (Eds.), *Sage handbook of social psychology.* New York: Sage.

[52] Pronin, E., Steele, C. M., & Ross, L. (2004). Identity bifurcation in response to stereotype threat: Women and mathematics. Journal of Experimental Social Psychology, 40, 152– 168.

[53] Good C., Rattan A. & Dweck C.S. (2012). Why do women opt out? Sense of belonging and women's representation in mathematics. J Pers Soc Psychol. 102(4), 700-717.