



Developing and piloting a survey to assess dissatisfaction of women in student teams

Dr. Laura Hirshfield, University of Michigan

Laura Hirshfield is a lecturer and researcher at the University of Michigan. She received her B.S. from the University of Michigan and her Ph.D. from Purdue University, both in chemical engineering. She then transitioned into the engineering education field with postdoctoral positions at Oregon State University, Olin College of Engineering and University of Michigan. Her research interests lie in assessing and amending curricula to help students transition from undergraduate to professional practice.

Dr. Robin Fowler, University of Michigan

Robin Fowler is a lecturer in the Program in Technical Communication at the University of Michigan. She enjoys serving as a "communication coach" to students throughout the curriculum, and she's especially excited to work with first year and senior students, as well as engineering project teams, as they navigate the more open-ended communication decisions involved in describing the products of open-ended design scenarios.

Introduction

In team support literature, it is not uncommon to suggest that faculty avoid stranding underrepresented students, like women, on a team [1], [2]. However, studies of gender dynamics on student teams paint a complicated picture; while pedagogical suggestions often prioritize not stranding or isolating women on teams, evidence recommending this strategy is often anecdotal. A recent study uncovered a surprising pattern of team satisfaction in first year engineering teams including women [3]. In that study, which considered data from 620 students engaged in 132 teams in a first-year engineering course, teams with only one woman were statistically more satisfied than teams with two or more women.

Motivated by this finding, a sequential exploratory mixed-methods study commenced. First, qualitative data was collected via interviews with female students in order to investigate common experiences that cause dissatisfaction for women on first-year team experiences. The analysis of these interview transcripts led to the development of a codebook, summarizing how female students perceive that they are treated as a female member of an engineering team; how that treatment causes them to feel; and how they behave in team projects in response to those feelings [4]. This qualitative data analysis then provided the foundation for the work described here: the development of a survey to be used to collect quantitative data. By using qualitative data to inform the collection of quantitative data, a survey instrument can be developed to study a “relatively unstudied area” [5] and to gather a larger set of data from a wider sample [6]. Although team experiences and gender dynamics are well-studied in engineering education, there is a need to better study and understand exactly how different team gender makeups can impact a female student’s experience, to better inform team formation and improve teaming experiences for all students.

Background

In the development of the interview protocol used in the first phase of data collection, many aspects of a student’s team experience were considered. In particular, interview questions were focused on probing reasons why a female student may have a dissatisfying team experience. Consequently, the resultant survey items presented in this work have to do with common difficulties that arise for women in engineering student teams. While our work eventually aims to directly link these themes to gender makeup of a team to determine why isolated women may be more satisfied on team experiences, many of the themes present in our survey are already well-studied topics, as presented here.

The reasons that a female student might be unhappy with a team experience can range from societal expectations to interpersonal dynamics with team members [7]. Because most engineering contexts are still male-dominated, it is common that institutional norms, engineering course content, student and instructor behavior, and many other cultural elements of a student experience cater more towards male student interests and behaviors [8], [9].

One reason that a female student may be less happy on a student team is due to inequitable project work. There is a long-enduring stereotype that women are inherently unsuited to be engineers, which can lead to women feeling that they do not belong, to them having less confidence, or to them having less motivation to engage with project work [10]–[12]. Because of

this, female students may either take on or be assigned less technically-challenging project tasks as compared to their male counterparts, and thus they will not gain the same skills as their peers [13]. These inequitable task divisions can compound over a college program, exacerbating initially small differences between student experiences [14], [15]. Perhaps this sort of task division leads to the pattern in [16], which finds project-based learning beneficial for all students, but more beneficial for men than for women. In the first phase of the study presented here [4], female students described men as pushing them out of technical work, and women described themselves as taking on tasks that others weren't doing as "picking up slack" and as leadership. One pattern we noticed in that qualitative data was that this seemed to happen more when the engineering work was more "stereotypically masculine," including work in a machine shop and coding.

One study that focused specifically on the impact of gender makeup of a team on a female student's experience was that of Meadows and Sekaquaptewa [17], in which it was discovered that problematic differences in gendered task assignment did not disappear even when women were the majority of a team. In fact, on teams with a solo man, gendered patterns of task assignment were worse than on teams with more men.

There have also been studies that investigate how gender makeup of a team impacts the conversational norms within that team. In general, women in a male-dominated space - for example, first year engineering students - report feeling the need to assert themselves [13] but sometimes struggle to do so [18]. The presence of additional women on the team may change the conversational dynamic; women may find it easier to be heard when there are other women on the team [19]. However, [19] only finds this effect when the team is majority female; there was no difference between isolated women and women who were paired on teams. In fact, not even parity led to increased participation for women.

Methods

This work presented here is part of a larger mixed-methods study, employing an exploratory sequential study design: first, qualitative data were collected and analyzed, which then informed the development of a survey to collect quantitative data [5].

Qualitative Interview Analysis

As part of the qualitative study [4], fifteen interviews were conducted with female students, prompting them to reflect on their team project in their first-year engineering course and discuss what contributed to their satisfaction, or dissatisfaction, with their team experience. Students were asked to describe their team project; discuss which tasks they performed in the project and whether there were any tasks they wished they did more or less of; and to consider if their experience was impacted by their gender or the gender makeup of their team. Finally, they were shown a graph from [3], showing that gender makeup of the team is related to team satisfaction, and they were asked if they had ideas about how to explain that result.

Straus and Corbin's [20] three-step strategy was used to analyze the interview transcripts, by two experienced researchers as well as three research assistants. First, transcripts were coded via (1) open coding, in which key themes were identified. Next, those themes were categorized into

broader themes through (2) axial coding. Finally, through (3) selective coding, those themes were connected, and subcategories within each were identified. Next, through co-located meetings among the researchers, categories were iteratively compared to identify themes related to the students' perspectives, as suggested in [21]. The resulting themes were developed into a codebook [4].

Quantitative Survey Development

In order to reach a broader population and gather more data, a survey was developed. Following the exploratory sequential study design, the qualitative findings were used to inform the content of the survey. To first develop the survey, the authors of the paper worked independently and wrote several items pertaining to each theme in the codebook. The authors then worked together to edit the items and narrow it down to five items per theme, considering the best practices of survey development: ensuring wording was clear, concise, and straightforward; being sure that the item was directly assessing what needed to be assessed; and considering the relevance of the item to the student experience [22]. Items were all written to be statements that students could rate agreement with on a Likert scale, where 5 = strongly agree and 1 = strongly disagree. The survey developed now provides the foundation for a future pilot study, in order to analyze the suggested constructs and determine factor loading to pick the best survey item(s) that relate to each theme.

Results: Survey Items to Assess Women's Dissatisfaction in Teams

One goal of the survey is to be able to use the resultant data to determine whether themes identified in the interviews are related to the gender makeup of the team. Thus, before students begin the survey, they will first report the course project that they completed and the gender makeup of the team.

The bulk of the survey consists of items derived from themes in the codebook developed from the qualitative data analysis [4]. The codebook consists of three categories of themes: Treatment, Feelings, and Behaviors. *Treatment* codes refer to factors that were external to the woman on the team: to how women perceived that others treated them during project team experiences, whether that was from one of their teammates or the institutional culture of the university. *Feelings* codes refer to factors that were reported as internalized by the woman on the team: emotions they had or thoughts they had when interacting with others on their team or completing project work. *Behaviors* codes refer to actions performed by the woman on the team, typically related to taking on (or not taking on) tasks in the project. The codes within each of these three categories all impact each other and relate to each other: for example, the way a woman perceives she is being *treated* will impact how she *feels* and thus will influence how she *behaves*.

Following the codebook, then, these three categories were the basis for the survey items that were developed. In this section, we present each of the three categories of codes, and the corresponding survey items written for each code.

Treatment

Table 1 contains items that are based on themes in the interviews related to how women described being treated on teams. Themes in this category refer to both general treatment related to the male-coded culture of engineering, and also to specific ways that respondents perceived they were treated by peers or by teaching staff. Common treatments that female students perceived as contributing to their dissatisfaction on teams were ignorance, exclusion, and patronization.

Table 1. Survey items related to Treatment codes.

Theme	Definition	Survey Items
Male-coded institutional culture/course structure	Overarching engineering culture and/or course pedagogy or structure that traditionally caters towards males and stereotypically male topics or qualities	Topics in E100 seemed more geared towards men than women.
		My E100 instructors treated male students differently than female students.
		My E100 instructors seemed to think that male students are better suited for engineering than female students.
		CoE culture caters more towards male engineers than female engineers.
Ignorance	Others are oblivious to difficulties that women face in engineering disciplines	I felt that there were E100 male classmates that didn't understand the difficulties associated with being a female engineering student.
		I felt like other classmates didn't understand my experience as a female engineer.
		I had male classmates that were well-intentioned, but didn't really understand the complexities of being a female engineer.
		People in general are not aware of the differences in experiences between male and female engineering students.
		My male classmates did not seem to be very aware of difficulties that women face in engineering.
Exclusion	Others prevent women from participating or engaging fully, either knowingly or unknowingly	My teammates made me feel included.
		Others on my team had a different relationship with each other than they did with me.
		I felt like I participated less in team project activities than other teammates did.
		I did not participate in project tasks as much as I would have liked.
		I feel that my team members didn't trust me with some project tasks.
Patronization	Others make women feel inferior	I sometimes felt that I wasn't taken seriously by my E100 classmates
		The way some of my E100 teammates treated me sometimes made me feel inferior.
		Some of my E100 teammates made me feel that I wasn't good enough to be in engineering.
		My E100 teammates seemed to think that I wasn't as smart as them.
		My E100 instructors seemed to think I was not as smart as the male students.

Feelings

Women in interviews described a series of feelings they had while working on their first-year project teams; Table 2 includes the survey items developed related to these themes. Women discussed feeling pressure to represent their gender and not feeling like they could mess up, lest

they give all women in engineering a bad reputation. Women also discussed ways they felt they interacted with their teammates, whether that was being competitive or friendly with other women. Some women discussed feeling regret at what they did or did not do on a project team, or a lack of confidence (self-doubt).

Perhaps the most interesting finding from the interviews was of a phenomenon we are terming “co-awareness.” Some women reported having some sort of epiphany, when they realized that treatment that they experienced was also experienced by another person on their team, with whom they share a gender. Beverly Tatum describes young African Americans incorporating race into their social identity in elementary school [23]; we think first-year women in engineering may be seeing structural inequities and coming to a feminist identity as part of their team experiences, and this painful but important process might be facilitated by having one or more other women on the team.

Table 2. Survey items related to Feelings codes.

Theme	Definition	Survey Items
Representing their gender	Feeling pressure to prove themselves or speak on behalf of all women	On my E100 team, I felt I was representing all female engineers.
		In E100, I felt pressure to demonstrate that female engineers can succeed.
		In E100, I felt that I was judged on behalf of all female engineers.
		In E100, I worried that people would form impressions about all women engineers based on my performance.
		I felt like my E100 teammates made assumptions about female engineers based on my actions.
Competitive	Women feel that they need to establish superiority over others on their team	I felt like I was competing with other team members for project tasks.
		I worked hard to make sure I stood out over my other team members.
		I wanted people to think I was better than others on my team.
		I felt competitive with other team members.
		I compared myself often to my other team members.
Friendly with other women	Feeling a kinship specifically with other women on the team	I formed lasting friendships with my E100 teammates.
		I felt more connected with my team members than other students in the class.
		I found it easy to become friends with one or more teammates.
		I formed a strong bond with at least one of my team members.
		I developed a close friendship with at least one of my team members.
Co-awareness	Confiding in female teammate(s) and, together, realizing gendered behaviour that is occurring in the team	I had a team member I could confide in about frustrations with other team members.
		I became more aware of ways I was treated differently in a team after talking with another female student.
		Discussing my experience with female teammates has made me realize problematic behavior that occurs to women in engineering.
		Talking with other female students about my team experiences makes me feel validated.
		I had at least one teammate who was similar to me in important ways that let us support each other.
Regret	Feeling disappointed for doing or (more often) not doing something in the project	I wish I had pushed harder to take on more responsibility in my team.
		There were tasks that I wished I did less of in my E100 project.
		There were tasks that I wished I took on more in my E100 project.
		I look back on the project and wish I had done something differently.

		I could have learned more from the E100 project if I had done something differently.
Self-doubt	Lacking confidence	I was less confident in my engineering skills than my E100 teammates. I often second-guessed myself when completing E100 project tasks. I felt I was less equipped to succeed in engineering than my E100 teammates. I sometimes worried I was not good enough to be in engineering. I often worried that others might discover that I knew less than other engineering students.

Behaviors

Finally, women in interviews described how they behaved in response to their treatment and feelings that they experienced. Some of the behaviors described involved how they interacted with their other teammates – whether they made excuses for other’s behavior, asserted herself to her teammates, or even confronted others when problematic behavior arose. The rest of the behaviors identified had to do with task division: women typically described taking on stereotypical or unfavorable tasks in their teams, sometimes to pick up slack, or they described *not* taking on tasks with hopes of improving team performance. Table 3 includes the survey items developed that related to these themes.

Table 3. Survey items related to Behaviors codes.

Theme	Definition	Survey Items
Making excuses	Defending the behavior of a team member (typically male), often due to a friendship with that person	My treatment on the team was based only on my relevant knowledge and skills. Even though I had difficulties with my teammates, I knew their hearts were in the right place. Any differences in how we were treated on the team were due to differences in ability or motivation. I didn't do the technical tasks that I wanted to, but that's because my other teammates knew much more than I did. We were all treated the same, regardless of gender.
Asserting herself	Standing up for herself	I had to push harder than other people in my group to be heard. I had to defend my choices more than other students did. I had to work harder than others to be taken seriously. I sometimes felt pressure to act more stereotypically male in team settings I needed to be more assertive on the engineering team than I am with other groups of peers in my life.
Confronting others	Standing up for oneself or calling out bad behavior when observing poor treatment	When I feel like I am not being treated fairly, I feel equipped to push back I would have stood up for myself if I felt I was mistreated. I would have just "let things slide" if I felt there was sexist behavior in my group

			I could have called out my teammates if their actions made me uncomfortable.
			I would have felt comfortable pointing out if I was treated differently than my male teammates.
Taking on Tasks	Stereotypical tasks	Taking on a role that is traditionally and stereotypically assigned to women (i.e. notetaker, secretary, scheduler, writer, etc.)	I seemed to have more natural organizational skills than my E100 male teammates.
			I seemed to have better technical communication skills than my E100 male teammates.
			I was more likely to take notes at team meetings than my male teammates.
			I was more likely to be proactive in scheduling meetings than my male teammates.
			I noticed that I was often expected to take on stereotypically female roles in my group (i.e. note taker, project manager, writer).
	Unfavorable tasks	A team member assigns a woman to do a specific task, despite her not wanting to take on that role	I felt like I needed to pick up slack on teams to make sure things got done.
			I found myself doing undesirable parts of the project because otherwise they wouldn't have gotten done.
			Rather than nag my teammates to do things, I sometimes just did them.
			I felt like I did more tasks that I didn't like doing than my male teammates.
			I felt like I did less interesting work in team projects than my male teammates did.
Not Taking on Tasks	To improve team performance	Refraining from taking on certain project tasks for fear of negatively impacting the team	I worried about my performance negatively affecting the grades of my teammates.
			I was afraid to take on new tasks in the project in case I wouldn't do well enough.
			I didn't want to take on challenging project tasks and risk negatively impacting our team performance.
			I was more concerned with getting the best grade than with trying new things.
			I avoided certain tasks out of fear of disappointing the team.
	Due to lack of experience	Not doing a project task because she perceives that she has less experience than the other group members	I came to college with less engineering experience than my teammates.
			I pushed myself to take on tasks in the project that were new to me.
			I tended to take on tasks in the project that I already had experience in.
			I avoided tasks that I had a lack of experience with.
			I did not take on certain tasks in the project because I knew other team members would have more experience in them.

Conclusion

This paper discusses the second phase of a mixed-methods study; in the first phase, qualitative data was gathered via interviews in order to, in the second phase presented here, develop a survey intended to collect quantitative data. The interview findings provided a fascinating insight

into female students' experiences on teams, but did not allow for a generalization of how gender makeup of a team impacts team member's dissatisfaction (and satisfaction). A survey will allow for gathering a larger sample of data and reaching a broader range of students, and the results of the survey will allow for a thorough quantitative analysis to identify the specific treatments, feelings, or behaviors that are prevalent in teams with one woman, compared to teams with two or more.

Immediate future work related to this study involves piloting the survey, in order to narrow the number of items and prepare it for wider dissemination. After the survey has been piloted and refined, however, the next goal is to administer this survey to female students at our institution, querying their experiences in first-year team-based courses.

A research question guiding this future work is to determine which themes relate to the gender makeup of the team; for example, do female students take on more stereotypically female tasks when they are the only woman on a team? Do women feel more competitive on their team when they are paired with one or more other female students? Ultimately, the aim is to determine exactly why women who are isolated on teams have been found to be more satisfied than women who are paired on teams. Eventually, these findings can be used to inform team formation, to better scaffold team projects, and to better understand female students' negative experiences in order to make teamwork a better experience for all students.

References

- [1] B. Oakley, R. M. Felder, R. Brent, and I. Elhadj, "Turning student groups into effective teams," *J. Student Centered Learn.*, vol. 2, no. 1, pp. 9–34, 2004.
- [2] S. V. Rosser, "Group work in science, engineering and mathematics: consequences of ignoring gender and race," *Coll. Teach.*, vol. 46, no. 3, pp. 82–88, 1998.
- [3] R. Fowler, "Demographic effects on student-reported satisfaction with teams and teammates in a first-year, team-based, problem-based course," in *American Society for Engineering Education*, 2016.
- [4] L. J. Hirshfield and R. Fowler, "Understanding female students' dissatisfaction in first-year engineering teams," in *Research in Engineering Education Symposium*, 2018, pp. 1–9.
- [5] M. Borrego, E. P. Douglas, and C. T. Amelink, "Quantitative, qualitative, and mixed research methods in engineering education," *J. Eng. Educ.*, vol. 98, no. 1, pp. 53–66, 2009.
- [6] J. W. Creswell and V. L. Plano Clark, *Designing and Conducting Mixed Methods Research*, 2nd ed. SAGE Publications, Inc., 2010.
- [7] T. Dececchi, M. E. Timperon, and B. B. Dececchi, "A study of barriers to women's engineering education," *J. Gend. Stud.*, vol. 7, no. 1, pp. 21–38, 1998.
- [8] C. Hill, C. Corbett, and A. St Rose, "Why so few? Women in Science, Technology, Engineering, and Mathematics," 2010.
- [9] K. L. Tonso, "Student learning and gender," *J. Eng. Educ.*, vol. 85, no. 2, pp. 143–150, 1996.
- [10] E. Seymour and N. M. Hewitt, *Talking About Leaving: Why Undergraduate Leave the Sciences*, 12th ed. Boulder, CO: Westview Press, 2000.

- [11] R. M. Marra and B. Bogue, "Women engineering students' self-efficacy - a longitudinal multi-institution study," in *WEPAN - Women in Engineering Programs and Advocates Network*, 2006.
- [12] A. E. Bell, S. J. Spencer, E. Iserman, and C. E. R. Logel, "Stereotype threat and women's performance in engineering," *J. Eng. Educ.*, vol. 92, no. 4, pp. 307–312, 2003.
- [13] L. Hirshfield, "Equal but not equitable: Self-reported data obscures gendered differences in project teams," *IEEE Trans. Educ.*, vol. 61, no. 4, pp. 305–311, 2018.
- [14] L. J. Hirshfield and D. Chachra, "Comparing the impact of project experiences across the engineering curriculum," *Int. J. Res. Educ. Sci.*, vol. 5, no. 2, pp. 468–487, 2019.
- [15] R. R. Fowler and M. P. Su, "Gendered Risks of Team-Based Learning: A Model of Inequitable Task Allocation in Project-Based Learning," *IEEE Trans. Educ.*, vol. 61, no. 4, pp. 312–318, 2018.
- [16] L. Q. Prendergast, "Retention, success, and satisfaction of engineering students based on the first-year experience." Rutgers University-Graduate School-New Brunswick, 2013.
- [17] L. A. Meadows and D. Sekaquaptewa, "The effect of skewed gender composition on student participation in undergraduate engineering project teams," in *American Society for Engineering Education*, 2011.
- [18] S. Ingram and A. Parker, "Gender and modes of collaboration in an engineering classroom: A profile of two women on student teams," *J. Bus. Tech. Commun.*, vol. 16, no. 1, pp. 33–68, 2002.
- [19] N. Dasgupta, M. M. Scircle, and M. Hunsinger, "Female peers in small work groups enhance women's motivation, verbal participation, and career aspirations in engineering.," *Proc. Natl. Acad. Sci.*, vol. 112, no. 16, pp. 4988–4993, Apr. 2015.
- [20] A. Straus and J. Corbin, "Basics of qualitative research: Grounded theory procedures and techniques." Newbury Park, CA: Sage, 1990.
- [21] M. B. Miles, A. M. Huberman, and J. Saldana, *Qualitative data analysis: A methods sourcebook*, 3rd ed. SAGE Publications, Inc., 2013.
- [22] R. Frary, "A Brief Guide to Questionnaire Development," 2012. [Online]. Available: <http://ericae.net/ft/tamu/vpiques3.htm>. [Accessed: 30-Oct-2016].
- [23] B. D. Tatum, *Why are all the Black kids sitting together in the cafeteria?: And other conversations about race*. Basic Books, 2017.