Gender and Teamwork: An Analysis of Professors’ Perspectives and Practices

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Abstract: Teamwork is increasingly seen as an important component of engineering education programs. Yet, prior research has shown that there are numerous ways in which teamwork is gendered, and can lead to negative experiences for women students. This article presents the first interview findings on professors’ perspectives on gender and teamwork. Semi-structured interviews were conducted with 39 engineering professors to determine what and how they thought about gender in engineering and engineering education. For this article, the parts of the interviews about teamwork are analyzed. We conclude that professors need tools to help them facilitate gender-inclusive teamwork, and those tools must address the beliefs that they already hold about teamwork. The findings raise questions about the adoption of evidence-based instructional practices and suggest current teamwork practices may exacerbate gender inequalities in engineering.

Keywords: Gender, Inclusivity, Professors, Teamwork, Evidence-based instructional practices, PBL

Introduction

Teamwork is increasingly seen as an important component of engineering education programs around the world (Beddoes, Jesiek, & Borrego, 2010; Borrego, Karlin, McNair, & Beddoes, 2013; Borri & Maffioli, 2007; de Campos, Dirani, Manrique & van Hattum-Janssen, 2012; Paretti, Cross, & Matusovich, 2014; Purzer, 2011). While recognizing the importance of teamwork, the negative aspects of teamwork must also be understood. Women students often have negative experiences on teams, and gender biases permeate all levels of teamwork (Meiksins, Layne, Beddoes, Martini, McCusker, Rideau, & Shah, 2016; Meiksins, Layne, Beddoes, Masters, Roediger, & Shah, 2017; Meadows, Sekaquaptewa, Paretti, Pawley, Jordan, Chachra, & Minerick, 2015; Mills, Ayre, & Gill, 2010; Tonso, 2007; Tryptten, Pan, Foer, Shehab, & Walden, 2015; Walden, Foer, Pan, Shehab, & Tryptten, 2015). Numerous problems, such as women taking on the management rather than technical roles, have been identified (Chachra, 2012). Teams in the workplace have also disadvantaged women (Ollilainen & Calasanti, 2007; Sarsons, 2015; Trimble, 2012; Wolfers, 2016). Thus, there is cause for concern when the virtues of teamwork are extolled without recognition of gender biases. The most recent annual literature
review of the Society of Women Engineers, which covers European and international sources, identified teamwork as an emergent research theme and emphasized the need for further research on the dynamics of teamwork and underrepresentation (Meiksins et al., 2016).

In order to contribute to the current conversation on gender and teamwork in engineering education, and to better understand professors’ teamwork practices, this article addresses the following questions: What perspectives do engineering professors have on gender in teamwork, and do their pedagogical practices for implementing teamwork account for gender? The article begins with a two-part literature review on team formation, and student experiences of teamwork. The literature covered represents international perspectives and was drawn from Europe, Australasia, and North America. Next, the methods of the study are described. The findings are then presented in sections that mirror the literature review sections. The Discussion reflects on four important issues from the findings. The article concludes by elaborating on the risks of increased implementation of teamwork without a concomitant attention to gender, and the need for tools to help faculty facilitate gender-inclusive teamwork.

Literature Review

Team Formation

One of the first decisions that will be made when implementing teamwork is how students will be distributed among teams, which we refer to as team formation, and have discussed elsewhere (Panther & Beddoes, 2015). The most basic decision to be made at this stage is whether students will be allowed to self-select into teams or if they will be assigned to teams. If being assigned to teams, then the decision must also be made whether to assign teams randomly or whether to purposely form teams based on characteristic(s) of the students. Examples of such characteristics can include gender, experience level, or students’ schedules. Research in this area has placed emphasis on aligning the formation method with the objectives of the teamwork activity (Hamlyn-Harris, Hurst, Von Baggo, & Bayley, 2006; McGourty & Demeuse, 2001).

The majority of research on team formation recommends that teams be assigned by the instructor and characteristics of individual students be taken into consideration (Curşeu & Pluut, 2013). If students self-select their teams, they are likely to work only with others with whom they are familiar, which creates homogeneous groups and often limits learning opportunities (Daly & Worrell, 1993). When forming teams, gender is one of the characteristics that should be taken into consideration (Curşeu & Pluut, 2013), but exactly how gender should factor into team formation is widely debated. Some research advocates not placing one woman alone on a team of all men (or not “soloing” women, as it is often termed) (Meadows & Sekaquaptewa, 2013; Viallon & Martinot, 2009). The reasons given for not soloing women are that performance and self-efficacy are negatively affected and minorities, including women, are often treated poorly and can feel isolated (Kanter, 1977; Viallon & Martinot, 2009). Some research on the benefits of homogenous teams has found that all women groups lead to better outcomes for women in terms of grades and self-efficacy (Baker, Krause, Yaşar, Roberts, & Robinson-Kurpius, 2007; Meadows & Sekaquaptewa, 2013; Okudan & Bilén, 2003; Okudan, Horner, Bogue, Devon, & Russell, 2002; Shi, He, Wang, & Huan, 2015). While other research has identified a variety of benefits for heterogeneous teams, including higher complexity of the team’s collective knowledge (Cooper, Cox, Nammouz, Case, & Stevens, 2008; Curşeu & Pluut, 2013; Dunaway,
Researchers from Germany and the U.S. have recently begun to try to make sense of conflicting findings regarding the effect of gender diversity on team outcomes through meta-analysis and systematic literature review (Beddoes & Panther, Under review; Schneid, Isidor, Li & Kabst, 2015). Drawing generalizable conclusions about team formation from this body of research is difficult, not only because of the conflicting findings and recommendations, but also because the studies were conducted on different types of student populations, in different contexts, and by asking different research questions. As researchers from Australia note of team formation, “Although this seems a simple and straightforward question, unfortunately there is no simple and straightforward answer” (Mills, Ayre, & Gill, 2010, p. 143). Some recommendations, such as not soloing (Kanter, 1977), get repeated in publication after publication. However, as we will discuss, such recommendations may be oversimplified, especially as more research has been conducted in this area, and lack the nuance to account for the wide variety of factors related to gender in teamwork.

After students have been assigned to teams, a second important aspect of team formation that must be considered is whether or not to assign team roles to individual students. Often, when students self-select roles, women end up taking on the role of organizer, note taker, or secretary, and ultimately fall into the role of playing “mom” (Hirshfield, Chachra, Finelli, & Goodman, 2015; Meadows & Sekaquaptewa, 2013). This is a problem because, despite rhetoric around the importance of “soft” or “professional” skills, “technical” skills remain the most highly valued in practice (Anderson, Courter, McGlamery, Nathans-Kelly, & Nicometo, 2010; Lagesen & Sørensen, 2009; McIlwee & Robinson, 1992; Mills, Franzway, Gill, & Sharp, 2014; Trevelyan, 2010). In order to avoid this gendered phenomenon, instructors should assign and rotate team roles (Meadows & Sekaquaptewa, 2013; Stein, Aragon, Moreno, & Goodman, 2014). It is insufficient to simply instruct students to not leave the non-technical roles to women (Richards & Bilgin, 2012). Instructors should utilize a planned intervention for ensuring that students’ roles do not fall along gender lines (Stein et al., 2014).

**Team Facilitation and Student Experiences**

Team effectiveness research emphasizes not only the importance of the outcome or product of the team’s collaboration, but also how teamwork affects each member’s learning and wellbeing (Borrego et al., 2013; Imbrie, Maller, & Immekus, 2005; Purzer, 2011; Wageman, Hackman, & Lehman, 2005). Some resources exist to help instructors with this aspect of team facilitation (Wageman et al., 2005). However, facilitating teamwork with the aim of maximizing each student’s learning and well-being is often overlooked in favor of evaluating the final product only. This focus on product becomes a problem when considering gender in teamwork because much research on students’ experiences of teamwork shows that gender biases and negative experiences for women are prevalent, and that women have less positive views of teamwork than men (Hockings, DeAngelis, & Frey, 2008; Kaenzig, Hyatt, & Anderson, 2007; Miliszewska, Barker, Henderson, & Sztendur, 2006; Ro & Choi, 2011; Smart, Berry, Kumar, Kumar, & Scott, 2015; Wolfe & Powell, 2009). In Denmark, research into PBL courses has produced mixed findings, highlighting benefits as well as problems, (Du, 2006; Du & Kolmos, 2009). An overview of many of the problems women, and other underrepresented students, face
in teamwork is presented by Meadows et al. (2015). Such problems include not being recognized for their contributions, being “marginalized intellectually” by having their ideas ignored, and having to work on projects that are not topically meaningful or relevant to them (p. 5).

The most in-depth study of gender and teamwork in engineering is Tonso’s ethnography of multiple student teams (1996a, 1996b, 2007). Her study documented a wide range of problems encountered by women engineering students, and concluded that team-based design classes are not more welcoming to women than lecture classes. Perhaps more troubling than the “overt hostility” and mistreatment itself, was Tonso’s finding that students seemed to learn those behaviors over the course of their engineering programs; they were not observed in first year students. More recently gender in engineering student competition teams has begun to be explored, with findings suggesting gender biases in those teams and the need for further intersectional studies of gender in teamwork (Pan, Shehab, Foor, Trytten, & Walden, 2015; Trytten, Pan, & Foor, 2015; Walden, Foor, Pan, Shehab, & Trytten, 2015.) Taken as a whole, these studies provide significant evidence that teamwork is often a site in which gender biases manifest and that professors are not successfully facilitating gender inclusive teamwork.

**Methods**

**Methodology**

Methodology is “a theory and analysis of how research does or should proceed;” it is distinct from, but should be related to, methods, which are “techniques for gathering evidence” (Harding, 1987, pp. 2-3). The methodology behind this project is “studying up.” Studying up means to study people in positions of higher social status or power, or institutions more generally (Nader 1974; Sprague, 2005). Studying up stands in contrast to “studying down,” which is the trend in social science to study – and often locate problems within – groups and individuals who are in positions of lower social status and power (Nader 1974; Sprague, 2005). In engineering education research, studying down typically manifests as the tendency to problematize women and other minority students, which has been critiqued (Beddoes, 2017, In press; Mills et al., 2010; Pawley, 2013; Riley, 2008). As the dominant mode of inquiry, it has led to gaps in our understandings of what and how faculty members think about gender. In order to begin to address those gaps, this study takes faculty members, rather than students, as its object of inquiry, joining other recent work, such as Walden et al. (2016), Blosser (2017), and Beddoes (In press).

**Participants and recruitment**

The participants for this study were thirty-nine engineering professors at three different public institutions in different parts of the United States. The institutions represented geographic and institutional-type diversity, including research-intensive and undergraduate focused institutions. As summarized in Table 1, the interviewees represented a mix of Assistant, Associate, and Full professors and a mix of engineering disciplines. Several interviewees also held administrative positions. There were eighteen women interviewees and twenty-one men. On an open-ended, optional demographic form given at the end of the interview (which all participants chose to complete), seven identified as Asian or Asian/white, two identified as
Recruitment was done through a combination of maximum variation sampling and purposeful random sampling (Patton, 1990), and recruitment efforts for this project have been discussed in detail elsewhere (Beddoes, 2015a). Public, departmental websites were used to randomly generate names. Yet, within the parameters of random sampling, purposeful steps were taken to recruit a full range of engineering disciplines, career levels, and an equal number of men and women. The goal was to recruit interviewees who were randomly selected in order to avoid a participant pool who all had involvement with “women in engineering” initiatives. However, the random sampling process did of course enroll some participants with involvement with women in engineering initiatives and those people were not excluded. A personalized email was sent to each potential participant explaining the study and offering them a $20 gift certificate to Amazon.com for participating. They were invited to reply to the lead author by phone or email if they were interested in scheduling an interview. At two institutions, colleagues helped with recruitment emails, as described in greater detail elsewhere (Beddoes, 2015a). The response rates at the three institutions were 28%, 40%, and 17%. It should be emphasized that this analysis is not intended as a critique of the individual professors who participated in this study. Rather, it is meant to provide new insights into professors’ practices and decision-making around teamwork and highlight issues that need further attention from the engineering education community.

Data collection and analysis

Table 1. Overview of Participants

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of participants</th>
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<tr>
<td>Career Level</td>
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<tr>
<td>Full professor</td>
<td>15</td>
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<tr>
<td>Assistant professor</td>
<td>13</td>
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<tr>
<td>Associate professor</td>
<td>11</td>
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<td>Gender</td>
<td></td>
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<tr>
<td>Men</td>
<td>21</td>
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<tr>
<td>Women</td>
<td>18</td>
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<tr>
<td>Discipline</td>
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<tr>
<td>Electrical/Computer</td>
<td>7</td>
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<tr>
<td>Civil/Environmental/Construction</td>
<td>6</td>
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<tr>
<td>Industrial/Operations/Manufacturing</td>
<td>5</td>
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<tr>
<td>Chemical/Biological</td>
<td>5</td>
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<tr>
<td>Mechanical</td>
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<td>Aerospace</td>
<td>3</td>
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<td>Nuclear</td>
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<td>Materials</td>
<td>3</td>
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<tr>
<td>Biomedical</td>
<td>1</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
</tr>
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In 2014 and 2015, semi-structured interviews (Singleton & Straits, 2010) were conducted by the lead author. The interviews averaged 60 minutes in length and were audio-recorded and then transcribed. They were all conducted in-person, except for two that were conducted via Skype. The interview protocol was designed to cover a wide range of topics that have been identified in prior literature as contributing to the gendering of engineering and/or women’s underrepresentation in engineering. The overarching aim of the interviews was to better understand what and how engineering professors think about gender in engineering, women’s underrepresentation in engineering, and how they make decisions around gender in their classes. One portion of the interview protocol covered teamwork issues specifically. Participants were asked about their practices, decision-making, and experiences regarding forming teams, assessing teams, and students’ experiences with teamwork. While many of the issues covered herein are relevant to other underrepresented groups, this study was about gender diversity specifically.

The teamwork portion of the interview protocol was developed from prior literature on gender and teamwork in engineering (e.g., Chachra, 2012; Mills, Ayre, & Gill, 2010; Tonso, 2007). For this analysis, transcripts were coded in two stages. First, responses to the team-specific questions were analyzed. Those questions included: How do participants form teams? What factors do participants consider when assigning teams? Do they consider gender when distributing students among teams? Have they observed negative team dynamics or interactions? Second, full transcripts were read for discussions of teamwork that appeared outside of the team-specific questions. All of that data was then coded as 1) team formation, 2) facilitation and student experiences, or 3) assessment. (Due to length considerations, Assessment will be discussed in future work.) Team formation included anything related to how and why students were distributed among teams, and among roles within their teams. Facilitation and student experiences included anything related to what professors did and observed over the course of the teamwork, and their thoughts about students’ experiences. Within each of those themes, responses then underwent open and axial coding (Corbin & Strauss, 2014) to identify sub-themes and to answer the research questions. As noted, the interview questions provided much of the structure for the analysis. Although the interviews focused on gender, participants sometimes chose to answer about race or nationality; thus, some quotations refer to students from underrepresented groups more broadly. In recognition of the diversity of participants, they are identified with numbers in this article, so as to avoid any implication of cultural or national origins that pseudonyms can imply.

**Limitations**

Several limitations of this study can be noted. First, this study was conducted only with educators in the United States. Second, participants came from only three institutions. Third, the interviews were designed to cover a wide range of topics related to women and gender in engineering; therefore, only limited time could be devoted to the topic of teamwork. Future studies devoted specifically to teamwork could delve further into these issues.

**Findings**

**Team Formation**
The primary findings related to team formation were: 1) that gender was given very little thought during team formation, 2) that participants utilize a wide range of methods for forming teams but often do not know why they use the method they do, and 3) that some participants know their practices go against recommendations from research but believe they have sound reasons for doing so.

For each team formation strategy, participants reported various reasons for choosing that strategy. For those who allowed students to self-form, the two most common reasons were that they thought students should be able to work with people they felt most “comfortable” with, and that the teams were working on projects with different topics and students should be able to pick the project that was topically the most appealing to them. Participants who formed teams also had a variety of reasons for doing so. Those who formed teams with no consideration of gender either had no specific rationale or engaged a discourse along the lines of, “You don’t get to pick your team in the real world so they need to get used to that now.” Those who took students’ gender into consideration when forming teams differed in both practice and reasoning. Some spread the women out across teams, others tried to ensure they had more than one woman on each team, and others said it varied.

A common theme in the discussions on team formation was that participants did not know why they did what they did. The following quotation from P17 is representative of what many said:

I just do it randomly right now. I’ve experimented with other models like putting all the girls together or making sure there are two girls in a team. I do it randomly now and I’m not exactly sure why I do it that way…I don’t know. I don’t know why I’m doing it that way. It could just be laziness. [Female full professor]

Similarly, when asked why he changed his practices, P23 chalked it up to laziness:

[Participant]: But actually, more recently in classes I’ve just allowed teams to form themselves and just allowed people to go with who they were closest to and not try to interfere too much.
[Interviewer]: Was there a reason you changed?
[Participant]: Laziness. I think. Well, also, I mean…[women] tend to sit in groups that they’re comfortable with. So I just let it happen naturally. [Male associate professor]

Another important finding related to team formation was that some participants stated that they know what the research recommends, but choose to not follow those recommendations. For example, P17 explained:

I know that the research says it’s better to have at least two girls in a group or something, and I think I just [do not do that] because I think well, work is like that, you’re going to be by yourself…I don’t know. I think it’s just mostly because you’re gonna have to deal with it, so you might be the only girl in a group and you have to just deal with it. I might do it differently now [after the interview]. [Female full professor]

P19 set aside research findings in favor of wanting to let students be “comfortable”: 

[In graduate school], I took a class in course design. There was a piece of research that suggested if you assign teams, it is better to have underrepresented students with other underrepresented students or always in the majority on a team. Just statistically they found the underrepresented students have better outcomes if you do it that way. For my classes though, I’ve been trying to let people self-select so they are more comfortable. [Male assistant professor]

P1 also did not follow commonly recommended practices because he believed his relationships with his individual students allowed him better insight into what the students needed:

I have heard that it’s not a good idea to have two men and one woman together on a team but I have not been really careful about making sure that doesn’t happen. I do use a little bit of my judgment based on my previous experience with the students when assigning teams. [Male assistant professor]

Others went against recommended “best practices” for other different reasons. For example, P10 (male full professor) said that he had had a negative experience one time: he had put the small number of women in the class together on one team (as the literature would recommend), but they were offended by this and had complained, so he stopped doing that. He said: “What I thought was this will give them strength in collaboration together, they have each other to work with. They did not appreciate that at all. They felt very offended that I did that. So after that experience I…let students choose their own teams.” In contrast, P22 said women had positive experiences when allowed to select all female teams for themselves:

Senior design teams where students typically get to pick their own teams, almost always the teams that have women will have more than one woman on it...In many cases you have all women teams. And I think that’s more a reaction to just wanting to be on a team where the women are confident that their voices are going to be heard because…a lot of women feel like they kind of get run over in a lot of experiences and other sorts of things where it’s mostly men and they’re the only woman. So I think letting people pick doesn’t necessarily give you the diversity you want….but if you have vulnerable populations, I think that’s challenging because then they may feel isolated and choose to opt-out. [Female full professor]

P9 (a male associate professor) purposefully did not put more than one woman on each team because he had observed that women tend to be team “leaders,” and so by putting more than one woman on a team he was taking that leadership opportunity away from a woman. P18 (another male associate professor) worried about getting in trouble if he followed recommended “best practices.” He reasoned that it is illegal to treat women any differently than men at the university and so he could lose his job if anyone knew he was taking gender into account when assigning teams.

Only two participants address team roles when forming teams. P17 (a female full professor) mentioned that she implements a rule that women cannot be the team note-takers. P21 (a female assistant professor) had a rule that all team members must take turns acting in each role to ensure that everyone has a chance to do everything. Otherwise, she said, the women get relegated to note taking and management roles and do not get experience with the hands-on
technical work. Troublingly, however, several other participants discussed this phenomenon but framed it as positive for women. They had observed that women often take on the management roles on the team, which the participants called “leadership” roles. They discussed this as evidence that women were not having problems or being discriminated against in teamwork. The tendency to see women’s “leadership” as positive may be preventing them from seeing how those roles can perpetuate gender inequalities in engineering, as discussed in the literature review.

**Team Facilitation and Student Experiences**

The primary findings related to team facilitation and student experiences were that: 1) some participants had witnessed problems, but many said they had never seen or heard of problems during teamwork, at the same time recognizing that they may not hear about such problems if they do occur, 2) participants expressed a lack of knowledge about how to intervene when they saw problems, and 3) some participants did not think it was a problem if women encounter gender biases in engineering education because that is preparing them for the workplace.

The vast majority of participants said that they had never observed or heard about a female student having a problem during teamwork. However, many would then go on to say that they are not in a position to see those problems even if they are occurring. For instance, when asked if they had observed any problems, only a few participants shared stories of gender-related problems they had observed or heard about during teamwork. P18 (a male associate professor) specifically described seeing a woman shut out of “technical” roles on the team, saying, “I think that the guys in the group basically shut her out from the more technical portion. She was in charge of project management and outreach.” He contrasted this with teams that had been majority female and in which he had not observed that problem. When asked if he had intervened in any way when he observed this problem, he said he had talked to the female student and asked if she wanted to take on more technical roles and she said “No” because she “didn’t want to screw up the team dynamics.” This phenomenon was also noted by P22 (a female full professor) who said she had observed, “A lot of presumptions about them [women] not being as technically strong, and taking on roles that are more culturally-normed for women.” P16 described how a female student had been shut out of the team entirely:

I think really it ultimately came down to just like negating the female student. So whatever she was doing, whatever she was saying was just not acknowledged or valued or trusted. So yeah, I think ultimately it came down to “You’re here, but I just don’t hear what you’re saying and anything you’re contributing is not going to make it into what we’re doing.” [Female full professor]

Similarly, P22 (a female full professor) said women students often tell her that their teammates will not hear an idea when it is said by a woman, but then when a man says the same idea, “everybody’s excited about it.”

One story from P16 highlighted the need to teach professors how to intervene when they see problems:
It was always a male student speaking or behaving badly towards a female student. Really in both cases I think it came down to that student not respecting – the male student not respecting the female student and my sense was it was because she was a woman and not just because they had a different opinion about something… I think it was a gender issue… But I did talk to him about it and I felt just totally inadequate leading a discussion about gender with those students at the time. [Female full professor]

As noted, some professors said that by not paying attention to gender when forming teams, they were helping to prepare students for the workplace. This discourse was also engaged in discussions of students’ experiences. P38 recognized that gender could affect team dynamics but that students needed to learn to overcome that:

I would hope that gender wouldn’t be a problem. But does that affect team dynamics and communication and things like that? It totally could. I guess I feel like that’s probably true everywhere in life, and that I guess people need to learn to overcome those things. [Female assistant professor]

The same idea was expressed by P15 who said women need to “build up strength” so he did not care if they encountered problems in engineering courses:

With anything done as a team, there might be some bias, but again that’s assuming that more women than men are less forceful on a team…and I’m not sure if that is true or not. And in the end, I don’t really care because if they’re going to be successful on engineering teams they need to build up strength, so maybe it’s good to deal with it a few times and realize that you need to speak up. [Male full professor]

P4 said the same thing when discussing working with people you might have problems with, even while recognizing that it could lead to attrition from engineering programs:

I mean, the fact is that it’s real life, too. I mean, you’re going to run into people like that [who have biases against women] in real life, as well. And so part of it is experience in that, and being able to navigate it. But I could imagine that there are certain instances where a person would get turned off, you know if they had multiple – or maybe it would only take one of those types of experiences to say, “Hey, this [engineering] isn’t for me.” [Male associate professor]

Several male professors recognized that the nature of teamwork in engineering could cause other problems for women, vaguely broaching the subject of sexualized environments and safety, which we have discussed in greater detail elsewhere (Beddoes, 2015b), and which should be given greater attention given findings on sexual harassment in STEM (Meiksins et al., 2016; Tonso, 2007).

**Discussion**

Based on these findings, four important issues were identified for further discussion. Each of these issues provides an example of new insights gleaned from studying up. The first
issue is that most professors in this study reported rarely thinking about gender in teamwork. Our findings thus share some similarities to those of Paretti, Cross, and Matusovich (2014) who found that the majority of engineering professors do not utilize recommended criteria for effective teamwork. Notable exceptions are described in the Findings above, but for the most part, participants did not have rationales for how they form teams, do not actively manage team roles, do not have effective mechanisms for identifying problems among students on teams, and do not facilitate gender-inclusive teamwork practices. Current practices and tools do not prioritize gender inclusivity, so while troubling, it is perhaps not surprising that most participants did not see gender biases or know how to minimize them. The finding that most participants had not put a great deal of time into reflecting upon their teamwork practices aligns with other research that found that engineering instructors focus most of their course planning and decision-making on lectures, as opposed to other course components (Peters, Beddoes, Brown, & Chang, 2016).

Second, in addition to the lack of attention given to gender in teamwork, we also found that some participants believed it was actually good for women students to have negative teamwork experiences. Those professors who thought this reasoned that women would have negative experiences in their future workplaces, so letting them have negative experiences as an undergraduate was simply preparing them well. They said that having negative teamwork experiences as an undergraduate would toughen them up and help them learn how to deal with such challenges. Setting aside the masculine cultures such beliefs feed into, there are practical problems with this line of reasoning. Rather than making them “stronger,” negative teamwork experiences may cause women to leave engineering programs. Even if we accept that as students, women need to learn to deal with negative teamwork experiences, nothing is being done to help them learn successful coping strategies. Instead, it is being assumed that they will automatically know how to understand, process, and learn from those experiences, ultimately taking away knowledge or skills that will help them succeed in the workplace. Contending that negative teamwork experiences are good for women fundamentally perpetuates the status quo of underrepresentation in engineering. What if “preparing students for the workplace” meant teaching majority students about gender biases in teamwork instead?

Third, we observed participants framing another known problem as positive. As discussed in the Literature Review, women often take on the non-technical roles in teams (Chachra, 2012; Meadows & Sekaquaptewa, 2014). The problem with this, however, is that in engineering cultures, it is still the “technical” work that tends to be more highly valued, despite increasing rhetorical assertions that “soft” skills should be valued (Anderson et al., 2010; Faulkner, 2000; Lagesen & Sorensen, 2009; Mills et al., 2014; Trevelyan, 2010). What we saw in the interviews was that some participants did not see this phenomenon as a problem because they interpreted it as a positive that women were taking on “leadership” roles. That interpretation of the phenomenon not only hides the problems with it, but also presents a gendered facet of teamwork as a sign of progress for women in engineering. This problem was also recently seen by Walden and colleagues in their study of design competition teams (Walden et al., 2016), and may present an important research horizon.

Fourth, these findings raise questions about the adoption of evidence-based instructional practices (EBIP) (Borrego, Cutler, Prince, Henderson, & Froyd, 2013). Diffusion and adoption of EBIP have received much attention in engineering education research in recent years (Besterfield-Sacre, Cox, Borrego, Beddoes, & Zhu, 2014; Borrego, Cutler, Prince, Henderson, & Froyd, 2013; Borrego, Froyd, & Hall, 2010; Borrego & Henderson, 2014). What we observed in
the interviews aligns in some ways with findings from that body of research, but also presents new issues for consideration. The self-labeled “laziness” that prevented some participants from adopting recommended team formation practices, for example, could be interpreted as a reflection of time constraints and the pressure to focus on research, which have been identified as barriers to adoption of EBIP (Besterfield-Sacre et al., 2014). The decision not to adopt a known EBIP because one believes s/he knows better (based on personal experiences or opinion) can be seen as an example of “Compatibility” considerations from Rogers’ Diffusion of Innovation theory. In that theory, “compatibility” is how well an innovation aligns with one’s personal beliefs and experience (Rogers, 2003). We observed this trend both in participants’ decisions not to follow “soloing” recommendations and in their assertions that it was good to let women students have negative experiences. This suggests that instruction of best practices may not be enough. Faculty development materials likely need to address the specific beliefs instructors hold that prevent them from adopting EBIP. For example, materials may need to grapple with the belief that gender-inclusive practices are illegal, or that professors are doing women a favor by letting them have bad experiences. This is one reason that more studying up is needed, to identify what those beliefs are.

Yet, these findings, combined with the literature review, also raise questions about the EBIP and recommended “best practices” that we have for gender-inclusive teamwork, and highlight the need for further research. In important ways, the recommendations around gender and teamwork differ from other EBIP in that many are not based in consistent findings from large amounts of empirical research. As discussed, for example, one of the leading “best practices” is to not isolate one female student on a team of all men. However, this recommendation did not emerge from systematic research around this question, and has been critiqued as over-simplified (Mills et al., 2014). Furthermore, Trytten et al.’s (2015) study clearly shows that women teammates do not automatically bond or help each other, and in our study, some participants had legitimate reasons for rejecting the recommendation. Therefore, more research is needed on EBIP for gender-inclusive teamwork, as are better understandings of how professors’ expertise, based on their experiences in the classroom, influences implementation of evidence based instructional practices for teamwork.

Research on factors that shape pedagogical choices, and changes thereto, is limited and in need of further examination (Lattuca, 2011). By studying up, this project contributes to broader discussions in science and engineering education, namely why faculty members do or do not adopt certain pedagogical practices (Borrego, Froyd, & Hall, 2010; Cutler, Borrego, Henderson, Prince, & Froyd, 2012; Henderson, Finkelstein, & Beach, 2010), which build on a longer history of studies on faculty members’ decision making (Blackburn & Lawrence, 1995; Eimers, 1999; Serow, Brawner, & Demery, 1999; Stark, 2000). The tendency to study down has led to significant gaps in research on faculty and limited faculty development initiatives in favor of student interventions. These limitations and the consequent gaps in research and interventions focused on faculty are a problem because faculty members play a pivotal role in students’ experiences of engineering education.

Before concluding, we should again note that this analysis is not intended as a critique of the individual professors who participated in this study, but instead as a way to provide new insights into professors’ practices and decision-making around teamwork that need further attention from the engineering education community. Additionally, it is worth reiterating that our findings are from interviews with professors who cared enough to take the time to participate in an interview about gender. It is reasonable to suggest that they may represent the upper end of
the spectrum in terms of the extent to which gender is a concern in decision-making around teamwork practices. In other words, there could be an even greater need for additional training and attention to gender inclusive teamwork than these findings suggest.

**Conclusion**

Teamwork is a large component of engineering, and its importance is increasingly asserted. Teamwork is also a site of many potential gender biases. Unfortunately, for the most part, teamwork is being implemented and facilitated with little, if any, attention to gender. There is much room and need for deeper and broader consideration of gender as the push for teamwork continues to grow. If the gendered facets of teamwork are ignored, teamwork then risks entrenching and perpetuating gender biases in engineering education. Furthermore, problems may be exacerbated as teamwork is conscripted into reforms that promote dominant masculine cultures, as one male assistant professor worried:

…the way that the program is structured is about how engineers need to be team workers and good communicators. And it’s this ideal of…it feels “bro-y” to me, sort of the bro-y engineer. Like, he could be in business, but he’s an engineer…And it has all these gender traits that I don’t like, and also these racial traits that I don’t like. It has these elements where it feels like the engineer is a frat dude that’s going to do really well because he knows how to talk to people and he’s charismatic and et cetera…I can’t even envision how this archetype that they put forward of an engineer is something [other than a man]. And that really bothers me.

Yet, most engineering professors would need help to plan and facilitate more gender-inclusive teamwork. As one participant explained, teamwork can support diversity in engineering, but only if we “teach faculty how to teach it.” Likewise, we cannot assume that students will automatically benefit from, learn from, or know what to do in team situations; they also need to be taught (Beddoes & Borrego, 2014; Popock, 2016). Addressing these challenges should accompany efforts to promote teamwork. It is clear that professors will need tools and resources to plan, facilitate, and assess teamwork in ways that minimize the likelihood of gender biases. It is equally clear that those developing tools and resources will need to grapple with beliefs that some gendered facets of teamwork do not need to change. To that end, we have created an open-access online training tool designed to help faculty facilitate more gender-inclusive teamwork. The tool is called **TARGIT** (Training and Resources for Gender-Inclusive Teamwork), and was co-created with two faculty development experts (Kappers, Beddoes, Cutler, & Panther, 2017; Panther, Beddoes, Cutler, & Kappers, Under review). The URL for TARGIT will be posted on <www.sociologyofengineering.org> when it is available.

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