



Teamwork in Engineering Undergraduate Classes: What Problems Do Students experience?

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Abstract

While teamwork is commonly integrated into engineering programs, it often discourages women and minorities. The purpose of the current research is to better understand what teamwork problems women and minorities most frequently encounter and the resources they currently have for solving these problems. The researchers report findings from a two-part study. In Part I, 677 engineering undergraduates at three different universities responded to a survey asking to what extent they had experienced different types of team problems in their STEM classes in the past year. 85% of participants reported they had at least one problem, the most common being a “slacker teammate.” Additionally, women were significantly more likely than men to report problems with feeling like they experienced limited learning because of their role on the team, and both women and under-represented minorities were significantly more likely than other groups to report being excluded from the main work of the team and having a domineering teammate.

To complement and further illuminate the survey results, Part II describes interviews with 63 undergraduates from seven different universities, where the researchers asked participants about problems they encountered during their engineering curriculum and to comment on problem scenarios. Findings suggest that students often lack resources for effectively solving team problems, though “high achieving” students, defined as having a self-reported GPA of 3.5 or above, are often more proactive when dealing with slacker teammates, using strategies such as setting early deadlines or selecting teammates known also to be high achievers. However, across the board, students preferred to “do nothing” when dealing with domineering or exclusionary teammates.

These findings shed light on the disproportionate burden women and under-represented minorities face in team projects and the lack of resources students have, pointing to a need for interventions to teach problem-solving skills.

Introduction

In 1996, ABET mandated the development of professional skills such as effective communication and working in teams through the EC2000 criteria. At the time, many educators welcomed this increasing emphasis on teamwork not only as preparation for workplace but also as a way to increase the participation of women and minorities in engineering (Brown, 2001; Ettenheim et al., 2000; Rosser, 1995; Teague, 1995). Team projects were thought to be particularly congenial to women because they promote learning through social interaction with others and can provide a cooperative balance to the often competitive atmosphere that dominates many science and engineering departments.

Unfortunately, however, the reality of such group experiences often proved demoralizing for women. Woodfield (2000), for instance, found that female professionals entering a computing company looked forward to working in teams, but found the practical experience of teamwork lacking, largely due to conflicts in collaborative styles that led to an under-recognition of women's contributions to the project. Many researchers have reported cases where racism and

sexism emerged in team contexts (Hewlett et al., 2008; Ingram and Parker, 2002; Neilsen et al, 1998; Tonso, 2007). Perhaps as a consequence, Neilsen and colleagues (1998) found many women shunning groups, stating that they preferred to work alone. Female engineering students in Natishan, Schmidt and Mead (2000) reported that gender was a “big deal” and that women often have to prove themselves before they were accepted as equals in the group.

One particularly troublesome consequence of these peer interactions is that teamwork often leads to unequal distribution of learning opportunities for men and women. For instance, Amelick and Creamer (2010), in a survey of engineering undergraduates, found that women and minorities complained about being delegated to non-technical work, such as preparing presentations and handouts. Perhaps more compellingly, in a study of over 500 engineering student team presentations, Meadows and Sekaquaptewa (2013) found that male students presented 20% more technical slides than would be expected if slide contents were equally distributed. Male students also spoke more during presentations and answered more questions than female group members. This unequal distribution of labor was correlated with self-perceptions of learning: students who presented technical slides and students who answered more questions perceived themselves as learning more during the presentation. These findings mirror those of other, smaller-scale studies that likewise found male students disproportionately assumed technical roles in projects while female students were more likely to complete writing and organizational work (Natashan, Schmidt & Mead, 2000; Wolfe & Alexander, 2005).

Yet, not only is teamwork a necessary part of students’ professional preparation, but team projects do have the potential to improve learning outcomes. A large body of research on collaborative learning points to the benefits of students’ learning from one another (Lave and Wenger, 1991; Mentkowski & Associates, 2000; Seymour and Hewitt, 1997; Prince and Felder, 2006). Prince (2004), in his review of literature on active learning, found that team-based approaches to learning can increase students’ skills, positive attitudes, and retention.

How, then, can we make student teams more equitable, over-coming well-documented trends where women have fewer opportunities than men to gain and demonstrate technical competence? How can we persuade women to persist on teams—and in their engineering career paths more broadly—despite interpersonal interactions that may make them question their belonging?

Before we can discover the answers to these pressing questions, we need a better understanding of the status quo: what problems do women and minorities most frequently encounter and what resources do they currently have for solving these problems? Understanding this status quo can not only help us develop interventions, but it can provide compelling data that we can use to persuade faculty, administrators, and other stakeholders that we need to invest time and effort into solving these problems.

Part I below reports a survey of students at three very different universities asking the extent to which they experienced various team problems. Part II provides an in-depth look at the experiences of 63 students who completed interviews describing their team experiences and the approaches they used in response to various difficulties encountered. Identifying students’ current problem-solving strategies is instrumental in developing effective interventions. By better understanding how students currently address problems, we can determine to what extent

we should support what students are currently doing, work to change students' mindsets, or focus on redesigning our curriculum and culture.

Part I: Survey of student team problems

Surveys were completed by 697 engineering undergraduates at three different universities: a private, high research university; a public, high research university; and a public, low research university. Of these 697 students, 20 opted not to record their gender or ethnicity, and were thus excluded from our analyses, leaving a total sample of 677 participants.

Slightly over one-third of the participants were female (n=228), and the remaining 66% were male (n=449). 15% were under-represented minorities (Hispanic = 62; African-American = 40) with the rest split between White (n=296) and Asian (n=279). The most common majors in the sample were Electrical Engineering (36%), Mechanical Engineering (26%), Civil Engineering (11%), and Chemical Engineering (11%).

Students were asked to identify how many teams they had participated on in their science, engineering, or technology classes in the past year. Students were then asked about the following four situations:

- How often have you been on a team in the past year in which one of the team members missed meetings, turned in poor quality work, or in other ways was less than a full contributor to the project?
- How often have you been on a team in the past year in which one of the members shut down others' ideas and generally insisted on his or her own way?
- How often have you been on a team in the past year in which you felt excluded or cut off from the main work of the team? This may be because teammates turned in work without your knowledge, met without you present, or assigned you to minor parts of the project.
- How often have you been on a team in the past year in which you felt you would have had a better learning experience if you had been assigned to or worked on a different part of the project?

The first three situations were selected because—consistent with prior research (Natishan, Schmit & Mead, 2000; Oakley et al., 2007)—students in their interviews frequently mentioned problems with non-participating or domineering team members, or with teammates who were excluding. Such problems often had concrete implications for students' grades as well as less directly observable consequences for their learning, self-efficacy and sense of belonging. The final situation above was chosen because prior research indicates that women often end up assigned to less core technical content on engineering teams, which affects the amount that they perceive themselves learning (Meadows & Sekaquaptewa, 2013). We do note, however, that this situation did not emerge as a theme in our interviews, probably because—as Meadows and Sekaquaptewa argue—students saw their assignment to non-technical work as self-determined, and therefore not an issue they thought to complain about.

Part I Results

Students routinely encounter problems in their teams

Consistent with the EC2000 criteria, 98% of students (n=664) reported participating on at least one team, with the average student participating in three teams in the most recent year.

Table 1 shows that team problems are very common: 85% of engineering students reported at least one team problem in their STEM classes in the most recent year. Moreover, many of these issues appear to have limited students' opportunities to reap the full benefits of the team experience. Nearly half of the students surveyed stated that they had experienced a project in which they would have had a better learning experience if they had been assigned to a different part of the project and almost one-third indicated they had been excluded from the main work of the team.

The most common problem was a "slacker" teammate who missed meetings, turned in poor quality work, or in other ways was less than a full contributor to the project. These results are consistent with Oakley et al. (2007) and Mead et al. (2005) who found that slacker teammates are among the most commonly reported team problems. After slacker teammates, limited learning opportunities and then domineering teammates were the most common problems encountered.

No differences were found for institution: students at all three schools reported problems to approximately the same extent.

Table 1. Percentages of Males and Females Reporting Teamwork Problems in the most recent year

<i>Gender</i>	<i>Slacker Teammate</i>	<i>Domineering Teammate</i>	<i>Limited Learning</i>	<i>Excluded from main work</i>	<i>Any problem</i>
Females (n=228)	78%	50%*	56%*	40%*	87%
Males (n=449)	73%	37%	40%	25%	84%

* $p < .01$

Female students report significantly more team problems than their male peers

Particularly concerning is the gender divide shown in Table 1. Chi-square tests show that women were significantly more likely than men to report problems with domineering teammates ($\chi^2 = 9.85$ (1), $p < 0.01$), feeling as though they could have had a better learning experience working on another part of the project ($\chi^2 = 13.61$, $p < 0.01$) and being excluded from the main work of the project ($\chi^2 = 20.6$ (1), $p < 0.01$). While it is unclear whether women in fact encountered more negative experiences—or simply perceived their experiences more acutely than men—this survey strongly suggests that gender affects students' team experiences. Moreover, the finding that women felt they had encountered limited learning opportunities because of their roles on the team, or had been excluded from the main work of the project, is consistent with observational studies that have found that women do less technical work on mixed-gendered technical teams (Meadows & Sekaquaptewa, 2013; Wolfe & Alexander, 2005).

Underrepresented minorities report significantly more team problems than others

Approximately 15% of our survey sample identified themselves as either African American or Hispanic, both groups that are under-represented in engineering. Table 2 shows that these under-represented minorities reported significantly more problems with domineering teammates ($\chi^2 = 7.36$ (1), $p < 0.01$) and more situations in which they were excluded from the main work of the team ($\chi^2 = 15.56$ (1), $p < 0.01$).

Table 2: Percentages of Students Reporting Teamwork Problems in the most recent year by Ethnicity

Ethnicity	<i>Slacker Teammate</i>	<i>Domineering Teammate</i>	<i>Limited Learning</i>	<i>Excluded from main work</i>
Under-represented minority				
African American (n=40)	85%	51%	56%	34%
Hispanic (n=62)	79%	60%	52%	55%
All Under-represented (n=102)	82%	56%*	54%	45%*
Over-represented groups				
Asian (n=279)	64%	41%	43%	30%
White (n=296)	81%	37%	45%	25%
All Over-represented (n=575)	72%	39%	44%	27%

* $p < .01$

When ethnicity was examined in conjunction with gender, the results become even more pronounced. Table 3 reveals that under-represented minority females reported more of every type of problem than White or Asian females: underrepresented women reported more slacker situations ($\chi^2 = 7.68$ (1), $p < 0.01$), domineering teammates ($\chi^2 = 4.55$ (1), $p < 0.05$), situations where they felt that their learning was limited ($\chi^2 = 4.35$ (1), $p < 0.05$), and situations where they felt excluded from the main work of the project ($\chi^2 = 5.83$ (1), $p < 0.01$). Likewise, underrepresented minority males reported more issues with domineering teammates ($\chi^2 = 5.05$ (1), $p < 0.05$), and more situations in which they were excluded from the main work of the team compared to White and Asian males ($\chi^2 = 9.15$ (1), $p < 0.01$).

Table 3: Percentages of Students Reporting Teamwork Problems in the most recent year by Ethnicity and Gender

Ethnicity	<i>Slacker Teammate</i>	<i>Domineering Teammate</i>	<i>Limited Learning</i>	<i>Excluded from main work</i>
Female students				
Under-represented minority (n=38)	95%*	66%†	77%†	58%*
Whites and Asians (n=190)	74%	47%	53%	37%
Male students				
Under-represented minority (n=64)	73%	50%†	44%	41%*
Whites and Asians (n=385)	72%	35%	40%	23%

† = $p < .05$; * $p < .01$

Part I Discussion

The results of this survey highlight the prevalence of team problems in the engineering curriculum: over three-fourths of students indicated an issue with a teammate or their role on a team. The mere presence of team problems is not necessarily a cause for concern, since a major rationale for assigning team projects is to have students learn how to work out such conflict. However, these findings do emphasize the need for instruction that will help students productively respond to team problems.

Moreover, the survey sheds light on the disproportionate burden women and under-represented minorities face in team projects. Of particular concern is that women and minorities were significantly more likely than others to report being on a project where they felt excluded from the main work of the team. This finding echoes that of Meadows and Sekaquaptewa (2013) observations of over 500 student team presentations, where women were marginalized from the core technical components of the team projects. Although some of this exclusion is self-selected—women often volunteer for less technical portions of the project—this pattern should concern educators since it indicates that women and minorities may be exposed to fewer learning opportunities and fewer opportunities for visibility on highly valued work.

Part II: Interviews

We complement these survey findings with interviews of 63 engineering undergraduates from seven different universities. Of these, roughly half ($n=30$) were from public, high research universities; 19 were from private, high research universities; and 14 were from public, low research universities. These universities were spread across the United States.

Nearly two-thirds ($n=41/63$) of the interview participants were female and nearly half were under-represented minorities: there were 18 Hispanic, 11 African American, 2 Native American, 6 Asian, and 24 White students. Nine students were sophomores, 23 juniors, and 31 seniors. The most common engineering disciplines represented were mechanical ($n=13$), chemical ($n=12$), biomechanical ($n=11$), electrical and computing ($n=11$), and civil ($n=9$).

We attempted to recruit students from a range of academic levels. We classified 17 students as high achievers, meaning they had a self-reported GPA of 3.5 or above; 24 as average, with a GPA between 3.4 and 2.9, and 22 as lower achiever, with a GPA below 2.9.

For approximately two weeks prior to the interview, participants were asked to keep a diary logging every time they felt like complaining or asking for help. Interviews began by asking students to elaborate on their diary entries. The interviews were semi-structured with some questions asked of every participant, but plenty of space to follow up on particular topics of interest. Most interviews lasted 60-75 minutes.

All participants were asked what they liked best and least about engineering; the most difficult team interaction they had had; the most difficult situation with a professor they had experienced; and the most difficult communication challenge they had faced in their engineering work. Students were also shown some common scenarios that other engineering students had encountered and asked to comment on them.

We coded the interviews for the types of team problems students encountered (i.e., slackers, domineering teammates, exclusion) and the types of solutions they said they would utilize to respond to these situations (i.e., do nothing, confront behavior, speak to the professor). For the purpose of this paper, we focus on the areas where there were significant gender differences.

Part II: Results

Interview participants resembled survey participants

The students we interviewed resembled those who took the survey: 71% (45/63) reported problems with slacker teammates; 48% (30/63) reported domineering teammates and 22% (14/63) reported being excluded from the main work of the project. As with our survey results, women were more likely than men to encounter problems with domineering teammates and exclusion (63% for women versus 41% of men), a difference that was marginally significant, $\chi^2(1)=2.937$, $p < .10$. Under-represented minority women experienced more problems with domineering and exclusion than other groups, with 70% (16/23) reporting such problems, although the difference is not statistically significant.

Domineering and exclusion had emotional costs and were often linked to sexism or racism

While not as common as slacking, domineering and exclusion often had higher emotional costs for students who felt that their teammates were questioning their competence. Many students felt they were being singled out because the domineering individual did not respect their intelligence or experience.

I got angry just because I kept saying something, and nobody would listen, and I kept feeling, "I'm dumb," or something. (Hispanic female, private high research university, lower achiever)

There's specifically this one kid who just—I feel like he just shuts me down whenever—he attempts to. He attempts to shut me down whenever I talk. I feel like he doesn't acknowledge my statements. I just feel like, whenever I speak, he weighs it less than when everybody else speaks. I don't really speak to him. The problem is, he comes off as nice. He's this super know-it-all that a lotta people within the department like, but I just don't feel respected by him. You take it in stride. (African American female, public high research university, average)

Well, sometimes it's between me and the team leader. He likes to—I think sometimes he doesn't really consider my ideas as much as he should.... He has a double major and he's pretty arrogant. (White male, public low research university, lower achiever)

Many students made a direct link between this disrespect and their gender or race, stating that their ideas were given less weight because they are not male:

It's tough, cuz the boys, they don't listen to you. They're just like—I've had some guys say, "You're a woman. You can't know better." It's like, "What?" (African-American female, private high research university, average)

I have friends in my classes. Let's say we'll be hanging out with a group of them and I'll be the only girl. They always find some reason why I'm not right. Even though it can be joking, it's still annoying sometimes because I can't even get a word in... You have some that are just arrogant and think they're geniuses. They're gonna talk over me because they don't think I'm as smart as them. (White female, public high research university, average)

Because I'm black and a female, it's like I feel that the impression is I don't have much to offer so it's like we won't really listen or what can you really add to this. (African-American female, public high research university, lower achiever)

Female students particularly worried that they received less challenging—or less technical—work on projects because of their gender or race. These women felt their male teammates did not trust them to handle the work:

The thing is, mostly in the engineering fields, boys, they don't take girls seriously even though maybe the girls would do better jobs....so especially in group projects some guys with some attitude just try to take over. (White female, public low research university, high achiever)

I feel like being a girl in the engineering field,...I feel like sometimes people talk down to me just because I'm a girl, and they think, "Oh, well, she doesn't know anything. We're just gonna do this ourselves." (White female, public low research university, average)

Tellingly, some male students also commented that their female peers' ideas and abilities were given less weight.

I feel like that would be annoying, as a girl. Your ideas are automatically thrown out just because you're a girl. (African-American male, private high research university, high achiever)

Especially in engineering, more so, I guess, just because of, you know, there's, you've got a group of guys or whatever, and they look at the girl or whatever and say: "You're not up to par with us." Which is absolutely not true at all. (African-American male, public high research university, lower achiever)

Exclusion could have major, tangible consequences for students

Exclusion often had consequences for students' grades. In one extreme case, a student told us of a project where she was specifically given a lower grade because she had done less technical work on the project—despite her repeated attempts to try to take on a more technical role:

What he did was he took those important parts for himself and the rest, we were just like technicians or maybe—we were just in labor, carrying stuff or—and I was so upset with him. The thing was, most of the people in the group, they were friends, so we mostly had task division. What he did—he wasn't calling me or they were just doing it and when I was asking he said, "Okay, don't worry. We just done it. We went to the lab and we just finished it." I got so mad and I went to the professor and said, "He doesn't—just share those projects, because I have to get a grade, too." He said, "You chose him as a leader, so you have to go take care of it."

I sent him a few e-mails and asked him, "Okay, you should just give me more tasks, you have to just make—" I don't know; he just never did. For the second semester of capstone I got B, because our professor said, "I didn't see you doing those electrical

engineering things,” and I said, “Because he didn’t let me. He didn’t give me this chance.”....

Even for presentation, he gave me just the business part of the project, not the technical, and I was presenting it very well and some of our professors came to me and they said it was good, but my professor said, “I didn’t see you talking about those technical things.” I said, “That’s what he told me to present. I just did what I was told.” (White female, public low research university, high achiever)

This case is especially compelling given that the student was a high achiever: thus, the team had no reason to question her competence. Moreover, her attempts to enlist the professor’s help may have backfired by alerting the professor to the fact that she was not fully participating. This team project carried a high emotional cost for the student—who expressed feelings of frustration, anger, and rejection—as well as had a tangible effect on her GPA.

Other students told us about situations where their grade on a project did not suffer, but their performance in the course was weakened because they had not met the learning objectives of the assignment:

She’d fly through it ...She didn’t really have time to teach me. That was one of those situations where I was just like, okay, I’m gonna stay back and let her do the work.... That class was not the class to do that for, so I ended up actually having to drop that class and retake it as a result. (African-American female, private high research university, average)

He would constantly be going to the lab and working on the lab without me, during times that I physically can’t be in the lab. He would do the majority of all these projects. I slowly learned less, and less, and less. It would be okay if it was just the class—the grade was just on the labs because we did awesome on all the labs just because he did so much of them. We also had tests in that class, where you had to test your knowledge of what you learned in the lab. He was, by then, hurting me because I wasn’t able to learn as much. (White female, public high research university, high achiever)

Some students told us of leaving volunteer organizations because of domineering or excluding teammates:

He’s like, “I’m a guy. I should be the top of the food chain and I’m the one doing construction. You could do your own paper” I stepped down from that position and went to a lower position than him but still I had more experience and I was more smarter than he was in the topic but he still treated me like I was below him. (Asian female, public low research university, lower achiever)

I joined last fall this group called Ecooperative...There was this one guy who, he seems like he knows everything. I thought he was a senior ready to graduate and he had been doing this for awhile. Turns out he was just a freshman who knew his stuff, but was really trying to take this team to the next level....Now because of all that he’s become the president and it’s like whatever he says goes, so I’ve kind of left that group because

they've taken a whole totally new direction with it and I just don't think it's worth it anymore to be in it. (Hispanic female, public high research university, average)

Thus we encountered cases where students received lower grades on projects because they were cut out of the work (despite repeated attempts to involve themselves), failed to meet the learning goals of the project because another teammate took over, or left volunteer organizations because another student took over and failed to listen to others.

Avoidance was a common solution but often carried high costs

One of the most common solutions to team problems was to do nothing. Students often rationalized that they should just wait until the project was over and avoid the teammate in the future. Such avoidance strategies carry a certain amount of logic, especially in school team projects which may be short-lived. However, there are also emotional and tangible costs to not speaking up. Students reported bottling up their anger, declining to participate, or letting a domineering teammate put down a wrong answer—all in order to avoid conflict.

For instance, one student told us of a teammate who failed to show up for meetings or complete work for an early part of a project, but she never confronted him about his absence:

I felt like if he didn't want to talk to me during the project, then I wasn't gonna talk to him.... I was still angry, but I tried to keep my emotions to myself and pretend like it never happened. (White female, public low research university, average)

Other students told us that they stopped participating in meetings when another student was forceful or domineering:

Sometimes, I think the best is just to stop talking. The more I talk then the more they talk over me or interrupt me the angrier I'm gonna get. Sometimes I just let it go, just don't worry about it. (White female, public high research university, average)

We had weekly meetings where I would get mad, and I would stop talking and stop saying things. (Hispanic female, private high research university, lower achiever)

The more and more I felt him cutting me off and me not getting my word across, I just left the group. (Hispanic female, public high research university, average)

I haven't [said anything] because I am scared that if I do, it's going to ruin the chemistry that we have in the group. I don't want it to be awkward, because I still have to work with them 'til the end of the semester. (Asian female, public low research university, lower achiever)

Many students described a reluctance to confront teammates about the quality of their work, even opting to change parts of their teammates' work rather than discuss concerns with them:

What ended up happening is that I ended up just either heavily editing or rewriting their parts. I didn't criticize them. I couldn't actually. I just couldn't muster up—I didn't want to stir up conflict in the group because as soon as someone criticizes, or as soon as I criticize, I'm always afraid that it sounds very judgmental or accusing. I don't want to

sound that way so I just don't say anything because I don't want there to be a conflict in the group. (Asian female, public high research university, high achiever)

I didn't really have the best group. A complaint there was just that they didn't really do any of their work or they would do the work, but it wasn't good quality work. Then I would have to redo it. Even though they tried, I ended up doing all the work for that. (White female, public high research university, average)

Some students used a final team member evaluation form to mark down teammates they had never confronted. Such practices could be unfair to teammates who did not realize there was any problem with their performance. For instance, one student expressed anger and confusion over having his contribution marked down:

Yesterday we got our grade back, and...[we] grade each other's performance. The top two got 86, and I got a 72 with the other person. I was not very happy about that.... They kept telling me [during the project], "Yes, it's okay, it's okay," acting...as if nothing was going wrong. They didn't tell me, "Hey, you're not doing—you need to do this...." I guess, based on the survey, based on my grade, I guess, they—on the survey they said that I wasn't living up to whatever they had. (Hispanic male, public low research university, average)

This student's frustration is understandable: his teammates' unwillingness to talk to him about the effort he was putting into the project had a substantial impact upon his grade. This student felt that his teammates had not adequately valued a major time-consuming part of the project that he had completed (although inadequately) by himself. As a consequence, this student asked the instructor if he could complete the next project alone: the major lesson he learned about teamwork on this project was that he wanted to avoid it as much as possible.

Avoidance is tempting because it often minimizes the negative emotional consequences of conflict (Bear, Weingart, Todorov, 2014), but it often backfires as a strategy. A recent meta-analysis of research (DeChurch et al., 2013) found that avoidant conflict management overall negatively affects team performance and team satisfaction. Moreover, Bear et al (2014) found that avoidance had fewer emotional benefits for women than for men. Thus, not only does avoidance (particularly avoiding conflicts over the task) fail to solve the problem, but it only provides women limited emotional help: women who avoided conflict experienced almost as much emotional exhaustion as those who confronted the conflict (Bear et al., 2014).

Just as importantly for student teams, avoiding conflict limits learning opportunities. This is perhaps clearest in the cases where students simply take over parts of the project rather than confronting teammates about low quality work. The under-performing teammates do not get an opportunity to learn from their mistakes, and the peers who take over do not learn how to work productively in a team.

Students who are confronted effectively about problematic behaviors—such as domineering—may be motivated to change their behavior. Several students told us about team building exercises where they received feedback that inspired them to change their behaviors:

I kinda went a little too overboard trying to get really good results. They saw it more as I'm intruding, and I'm not letting them do the work that they need to be able to present at some point. Thankfully, I realized it early...thanks to this team building aspect, where we're supposed to talk to each other about how we feel. I did tone it down. That was probably one of the first times that I realized I will never do this again, because I know how it feels. (Hispanic male, private high research university, average)

When I had an idea I would just start talking about it when someone was quiet. I didn't understand that they were still trying to say something....I've gotten a lot better about that as well. Once it's pointed out to you, you can usually see what you're doing and prevent it. If it's never pointed out, you never even notice it. That's why the first thing you do is talk with them and make sure they know. (White male, public low research university, average)

Such confrontation, however, must be done effectively to maximize benefit.

When students did confront problems they often used counter-productive strategies

Unfortunately, however, many students who did confront their teammates about behaviors such as domineering or exclusion ended up doing so in a combative style. These students openly voiced anger and frustration or corrected behaviors in ways that were not always well-received.

When I was president of SHPE [Hispanic student organization], we had one of our general meetingsThis guy just was rude, and he talked over me....I wanted to kick him out, cause he just really upset me.... I'm like, "Well, you're not an active member. You don't attend any of our events, you're just here for the food." I got him really good; I was just really frustrated. (Hispanic male, public low research university, average)

I had to be forceful in saying, "Look, you're making me angry. This isn't fair to me. You can't do this."... It got a little heated because I was so mad. (White female, public high research university, high achiever)

He was trying to do everything and tell everybody what to do and just explain everything and talk down to us. When I realized that he was wrong about some things, I told him so and when he still kept trying to do it, I told him, "Why don't you let us do something and you can just sit down and be quiet?" (Hispanic female, public high research university average)

This, after weeks and weeks of him just throwing me to the side and giving me really, really stupid tasks. I just kind of exploded and said "This is ridiculous and unacceptable" and might've thrown in some not-P.C. words (Hispanic male, public high research university, lower achiever)

I sent him an e-mail and I showed to his face that "I'm just so mad because you're not sharing the tasks." (White female, public low research university, high achiever)

The negative effects of these angry confrontations could be magnified when students confronted one another through text or email, rather than face to face:

Student: Finally, I, early on, confronted him. I was like, “I think you’re being unfair. If you want me to do something that I’m not, you need to directly tell me to do it. I’m also in the same place as you in engineering, so I know what I’m doing.”

Interviewer: Did you say all this through text message?

Student: Um-hmm. It’s an issue with our group. We’re really combative through email and text, but whenever we get together it’s just bye, break. My friend and I, we get so frustrated. Finally we’re just, we need to sit down and have a meeting. We have a meeting, no one says anything. No one’s honest... We used to be kind of good friends...and now I’m just, ugh, I can’t deal with him (White female, public high research university, average)

Such outbursts often had negative consequences: students reported losing friendships and falling in status after an angry confrontation. Moreover, anger is a dangerous strategy for women, who are perceived more negatively than men when displaying anger and other more aggressive communication strategies (Brescoll & Uhlmann, 2008; Farley, 2008; LaFrance, 1992). One female student discovered this double-standard the hard way when she mimicked one of her teammate’s aggressive interruptions:

There’s actually this guy in our class, he loves to talk and he just won’t let anyone get a word in. Sometimes if I try to talk, he’ll just keep talking as well. Just jokingly though, I’d try to pretend to interrupt him too...and he’s looking at me in bad looks...and then I get looked down upon as well. That was frustrating...Now I look even worse. First it was unnoticeable, now it’s, “Oh she’s really rude.” [*Laughter*] (Asian female, public low research university, lower achiever)

Although most of our female participants noted negative consequences for angry outbursts—including lost friendships and tense relationships with peers—some did feel like their angry confrontations earned their peers’ respect. One minority female—in what appears to be an example of what is controversially called the “double advantage effect” (Ladner 1971) for minority women—describes using her “Hispanic attitude” to confront a domineering teammate:

Then he tried to cut me off again, and my Hispanic attitude came out, and I was like I’m not gonna tell you again... We’re just throwing out ideas. Stop being rude and let me finish my statement. After that, I’ll listen to you....Sometimes with those type of guys, you need to do that, especially bein’ a female in a male dominated world. You have to kinda earn your respect. I think I earned my respect that night. (Hispanic female, public low research university, lower achiever)

When asked to elaborate on what she meant by a Hispanic attitude, this student explained “my mom calls it nasty-nice, how you have to sometimes be nasty, but in a nice way for you to get your point across to some hardheaded people...It’s just a quick snapping feisty attitude.”

However, not all minority women felt this freedom to use their anger and ethnicity as a resource. One African American student described taking extra steps to curb her anger so as not to be identified as an “angry black woman”:

People will always, they will always remember that. They will always remember that. I don't want that to be the one thing people remember about me is me being that over-aggressive black woman. Anything with a little too much sass I try to stay away from. I try to really use my words, as opposed to my attitude, to get through situations. (African-American female, private high research university, average)

While avoidance was the most common strategy students mentioned in responding to a problem, combative confrontation was usually their next solution. In fact, when we asked students who acknowledged that avoidance was the wrong solution to their problem to state what they *should* have done, many jumped to combative solutions:

So alpha-dog wise I never really stepped up to the plate or said anything but if I could, I would probably say, "You know what, you need to put your ego aside and realize that I'm actually smarter, more experienced than you are but I'm being more humble about it than you are." (Asian female, public low research university, lower achiever)

Such a combative, dismissive response is unlikely to have the effect the student would hope. However, it sheds light on why so many students chose to avoid confrontation: if the only alternative to silence students could imagine was aggressive confrontation, it is no wonder they often chose silence. Students clearly need more choices that can help them imagine a positive, professional confrontation that would not result in backlash.

Effective instructor intervention was rare and risked backfiring

Students also sought the assistance of their instructors in handling team problems, but such requests for assistance were often not fruitful and sometimes seemed to work against them. For example, when one student went to her professor about concerns about how her teammate's poor performance would affect her grade, the professor told her there was nothing he could do. The student concluded that she needed to complete all of the work herself. In another instance, when a student went to her professor about teammates who were meeting without her, the instructor placed responsibility on her to solve the problem, and then gave her a low grade on the project because he did not see her contributing as much as others. Instructors were reluctant to intervene in teams and few classroom parameters—other than giving students a mechanism for evaluating their teammates at the end of the project—were in place to ensure that work was evenly distributed.

Consequently, most of the time students did not inform their instructor of problem teammates—at least not until the project was over. Instructors rarely, if ever, learned about problems early enough to intervene. Students repeatedly told us that it was not worth going to the instructor to discuss team problems. Furthermore, there was a general sentiment that problem teammates are inevitable and there is little an instructor is willing, or even able, to do.

This sense that slackers and other problem teammates are inevitable was also expressed by many of the faculty Hunter (2009) interviewed. However, as we already established, many problems with slacker teammates—and, to a lesser extent, problems with exclusion—could have been prevented with clearer planning and communication about expectations. Such problems can be easily resolved by teaching students how to plan a project in advance and communicate expectations early rather than waiting for problems to arise and then work to solve them.

One reason that faculty may not intervene more in team projects may be that they simply do not have the knowledge base to trouble-shoot students' problems. Most faculty seem to have little knowledge of what experts consider essential team practices, such as developing task schedules or distributing minutes after meetings (Wolfe, 2010). If students are not given instruction on solving common team problems, team projects are just as likely to reinforce bad teamwork practices as they are to develop good ones. In fact, several students indicated to us that the major lesson they had learned from their team projects was how strongly they preferred to work alone:

Student: That's why—I don't know. I'm just considering about my career. If I work for a company and something like that [exclusion from the project followed by a low evaluation] happens and I have to just keep up with it, that's just torture....I'm looking for some jobs that maybe I can be more independent and not very involved.

Interviewer: Less teamwork?

Student: Exactly, yeah.

This does not mean that all faculty were uninvolved. Several students reported instances of successful instructor intervention when a domineering teammate insisted upon a solutions that student believed to be wrong. By asking the faculty to intervene, the student effectively redirected the conversation. However, problems that could be resolved by an expert opinion on the subject matter represented a minority of team problems. Students need more instruction and support that can help them effectively address common problems.

Conclusion

Our results confirm that team problems are very common among engineering students and students do not have good strategies for responding to them. Over 85% of the 677 students we surveyed reported at least one team problem in the past year. The problems were disproportionately concentrated among women and under-represented minorities—with minority women experiencing far more problems than any other group. Over half (58%) of minority women reported being excluded from the main work of the project, compared to 41% of minority men, 37% of White and Asian women and only 23% of White and Asian men.

Our interviews with 63 additional students indicate that students often perceive these problems as linked to their gender or race. Many women told us that their male peers gave their ideas less credit and failed to trust them with technical work on group projects, a finding consistent with Meadows and Sekaquaptewa (2013), Wolfe and Alexander (2005), Natishan, Schmidt and Mead (2000) and others. This lack of trust translated into a lack of learning opportunities and students who had been excluded from work on a project found their performance suffering when they failed to master the content a project was supposed to teach. In some cases, students who had been shut out of projects received lower grades because they had not contributed.

Students also lacked effective strategies for responding to these problems, with avoidance being the most common solution. Such avoidance often left students emotionally frustrated and limited their access to learning. However, many of the most common team problems could have been solved with more planning and more explicit discussion of project criteria and team norms. Such

students would benefit greatly from training in documents such as well-designed task schedules and team charters such as discussed in Wolfe (2010).

When students did confront teammates, they often used combative language to correct others or voice their anger and frustration. This confrontational language seems likely to backfire for women who have been found to suffer disproportionately negative consequences for expressing anger (Brescoll & Uhlmann 2008) or engaging in other aggressive behaviors associated with masculine communication styles (Farley, 2008; Bowles, Babcock & Lei, 2007). Students need more effective methods for responding to conflict such as those described in Wolfe and Powell's (2014) study of professional women engineers

Instructors rarely intervened in team conflicts and there were few mechanisms in place to help students negotiate even the most common team problems. In general, however, students appeared to think that there was little they could do to prevent team problems, short of avoiding individuals who had shown themselves to be problems in the past.

So what are next steps? Based on the findings described in this paper, we recommend that engineering educators consider ways that the following may be implemented into the engineering curriculum: teamwork instruction, information about effective interpersonal communication strategies, project management tools, and conflict management strategies. Students clearly need to expand the range of strategies they use to confront team problems. They need to learn how to productively and proactively address conflicts by implementing good planning, clear ground rules and procedures for team behaviors, and finding language that focuses on solutions and goals rather than dwelling on problems (Wolfe 2010; Wolfe & Powell 2014a; Wolfe & Powell 2014b). One way that faculty may help students strengthen their teamwork skills is by drawing on the expertise professionals have developed in their time in the field. Our results also indicate that faculty would benefit from learning more about the challenges students face, reasons why students may perform less effectively than peers on teams, and strategies for solving team problems. Thus, faculty and students can proactively face challenges rather than assuming that bad teamwork or slacker teammates are inevitable.

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