New Orleans JAZZED about Engineering Education

Paper ID #16360

Classifying Dissatisfaction: Student Perspectives on Teammate Performance

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Introduction

There are at least two different ways to evaluate student teaming experiences. One approach is to evaluate the *outcomes* of team-based work. This is commonly used for grading student work in light of how closely it maps onto professional practice, where teams are usually evaluated on the basis of what they produce. However, understanding the subjective student experience on teams is also important in terms of assessing and improving team function, because these types of experiences affect student's self-efficacy and motivation, which in turn affect their persistence and retention in engineering.

Peer assessments are widely used to both evaluate team function and to understand student experiences. Conventionally, they take a *top-down* approach: the creator of the peer assessment tool identifies acceptable team behaviors and the students assess each other on those behaviors. They also typically focus on *positive* aspects of teaming behavior. In this preliminary research study, we take a rather different approach to investigating the engineering student experience on teams. First, it is a *bottom-up* approach: students themselves describe their teammates and team experiences. Second, we focus on *negative* feedback and experiences, rather than positive. Our goal is to capture elements of teaming that may not be captured by the more widely-used approaches. A common example of negative teaming behavior is 'freeloaders', students who may devote little effort to the team but who benefit from the work of their teammates. Another example is when one student re-does work produced by a teammate; this will likely lead to a higher-quality output, an outcome which appears to be positive. However, the student whose work was re-done may find this to be a demotivating experience, undermining their confidence, which may in turn contribute to a lower commitment to engineering. Because teaming behavior is likely to reflect schemas around gender and race, underrepresented groups that are already at risk for leaving engineering may be disproportionately affected by negative team experiences. A more careful investigation of negative behaviors, particularly using the lens of motivation, may help educators improve teaming experiences.

Background

Teamwork is generally considered vitally important to engineering practice. Accordingly, ABET accreditation guidelines for programs require documented student outcomes of engineering curricula that include both 'an ability to function on multidisciplinary teams', and 'an ability to communicate effectively'.[6] In a survey of faculty, students, and industry professionals, communication was the highest-rated trait for graduates, with another study placing

communication, ability to work in teams, and interpersonal skills in the top five of a ranking of seventeen traits by importance to engineering practice.[1, 15]

While the development of teaming skills is useful in its own right, teamwork also promotes active learning, a process by which students meaningfully engage with the material rather than passively "soaking up" knowledge. Active learning enhances student understanding of material.[16] In team-based project work, students apply material taught in class to concrete goals and learn from, teach, and support one another as their skills grow. 'Encouraging cooperation among students' (collaboration, rather than competition) and 'encouraging active learning' (internalizing knowledge through interacting with it) are considered to be key good practices for educators.[6]

Peer assessments of teamwork:

The contributions of individual members, in different ways and at varying levels, aggregate to affect a team's performance.[19, 20] While the *outcome* of a teaming process can be assessed from outside the team, assessing how well a team is functioning may be difficult for an observer. Project work is often carried out away from direct supervision (i.e. outside of class time), so educators may not have the opportunity to observe poor behavior. If one group member is not leveraging their time and skills to contribute effectively to the project's completion, it likely will affect the experience of his or her peers before the situation is recognized by an educator. Accordingly, peer assessments are often used to assess teamwork. As a formative tool (while work on a project is in progress), peers can use their knowledge of the team's interpersonal workings to diagnose problems.[10] At the end of a project, peer assessments can be used to evaluate the contribution of each team member. In both cases, team evaluations are often used to avoid what is seen as a common problem in group work—"lazy students riding on the coattails of their hard-working peers"—by having students hold each other accountable for their actions. But more broadly, peer assessments would ideally capture a range of behaviors, both positive and negative, that affect the experience and productivity of students in team-based projects.

A number of peer assessment instruments have been created to evaluate individual performance within a group. Such instruments have been demonstrated to be valid, reliable, and relatively free from bias.[12] These scales generally identify a range of positive teaming behaviors, and students use a Likert scale to describe their peers' performance for each of them.[9, 22] Criteria generally used for peer evaluations include: commitment to the group, ability to deal constructively with conflicts (communication), active participation in decision making, accountability for assigned tasks, and assumption of initiative or a leadership role.[10]

In a meta-analysis of peer rating instruments, Baker identified eight basic components[2]

1. Attended group meetings; was available and on time
2. Was dependable, kept his or her word
3. Submitted quality work

4. Exerted effort and took an active role
5. Cooperated and communicated with others
6. Managed group conflict
7. Made cognitive contributions; possessed and applied necessary knowledge and skills
8. Provided structure for goal achievement

For most of the instruments, categories were selected based on "literature reviews, knowledge gained from previous group experience, and/or suggestions generated by the groups that would be using them"[2]—that is, they are largely based on personal experience and supraliminal thoughts as to what qualifies as positive collaborative conduct. While they bring the pedagogical goals and experience of the creator of the assessment to bear, these assessments may not necessarily reflect the observations, experiences, and perceptions of the teammates themselves.

For the preliminary work presented here, we took a very different approach to understanding peer assessment in teams. There is a tendency to presume that student teams can be described by the 'Anna Karenina Principle': "Happy families are all alike; every unhappy family is unhappy in its own way". That is, all teams that produce high-quality output must function well as a team, while 'unhappy' teams, producing low-quality output, function poorly for a host of different reasons. However, a team that produces high-quality output may *also* be 'unhappy': the experiences of team members may not necessarily have been positive or effective learning experiences.

For this study, we analyzed interviews with students about their teaming experiences, with a focus on negative experiences with peers. Rather than the top-down approach of most peer assessment instruments, this bottom-up approach allowed us to begin to create an emergent taxonomy of how students fail to contribute positively to their team, one that is rooted directly in the teaming experiences of the students themselves. By contrasting this taxonomy of negative behaviors with the existing taxonomies of positive behaviors, we can not only observe areas where there are positive and negative counterparts (i.e. took an active role/was not engaged) but also deepen our understanding of teaming experiences by identifying ways in which students may have negative experiences that aren't necessarily captured in a taxonomy focused on positive experiences. Note that, for this study, we did not assess the relative success and outcomes of a project (i.e. work quality, final grade), but focused solely on subjective perception of team experiences.

Self-determination theory:

Self-determination theory (SDT), the theoretical framework for this research, is a model of motivation that goes beyond the simplistic idea that students are motivated by the desire for reward or the fear of failure (a grade of an A or F, as it were). Instead, it describes a range of motivations, both intrinsic and extrinsic. Extrinsic motivation refers to doing an activity because one expects some external outcome, i.e. to "get something out of it". For example, a student may take a short course in which they have no interest in the belief that the certification they receive

at the end of the course will make them more marketable.[8] Some types of extrinsic motivation can lead to feelings of alienation and apathy. For example, when people cannot figure out what is expected of them or how to achieve competence, they may experience *amotivation*, a state of little to no motivation. Conversely, controlling environments that "demand, pressure, prod, and cajole people to behave, think, or feel in particular ways" result in *external regulation*, in which behaviors are "performed to satisfy an external demand or obtain an externally imposed reward contingency". Several other types of extrinsic motivation have been identified. *Introjected regulation* occurs when people feel pressure to act to avoid feelings of guilt or attain pride. *Identification (*or *identified regulation)* is motivation that is rooted in the recognition of the importance of a behavior to oneself. Finally, *integrated regulation* is the most self-directed of the varieties of extrinsic motivation. It occurs when "identified regulations have been fully assimilated to the self ", but the action is still valued as having some external consequence.[18]

In contrast to extrinsic motivation, intrinsic motivation results in engagement with an activity 'for its own sake'; that is, the student finds the activity inherently interesting or worthwhile. Intrinsic motivation promotes an ongoing sense of wellness, creativity, and improved performance on tasks, all of which relate directly to positive educational outcomes. Three psychological needs support this type of motivation. *Autonomy* is the level to which one's own sense of volition is not undermined by external factors; living autonomously means to feel deeply that one's actions are one's own choice. *Competence* is the need to feel effective in one's own environment, to regard oneself as being skilled. *Relatedness to others* is the need to care for and be cared for by others. The combination of these three factors leads to high levels of motivation, and particularly intrinsic motivation.[8]

A theoretical grounding that focuses on motivation is particularly appropriate for this work because one of the key negative behaviors on teams is "freeloading", which occurs when students do not contribute to team activities, but who benefit from the contribution of others. There is a temptation to view this as an immutable characteristic of these students and to see them as "lazy" or "slackers" without necessarily considering *why* they behave this way. All behavior (even choosing not to participate) springs from some sort of motivation. Understanding these motivations and their contexts can help educators structure learning experiences that are valuable and engaging for all students.

Methods

Data were collected on the student experiences in this course as part of a larger mixed-methods study on task choice and self-efficacy in project-based engineering design courses. The 100+ participants in this study were enrolled in five different courses at a large, public university in the midwestern United States, each of which included a substantial engineering design project that was carried out in teams. The larger research study involved pre- and post-course surveys, weekly activity logs, and semi-structured interviews at the end of the course which focused on

their teaming experiences and factors that may affect self-efficacy; it was these interviews that were used for the analyses presented here.

Interview participants included eleven first-years from two sections of the same design course, twelve sophomores from one mechanical engineering design course, and eight seniors from a chemical and an electrical engineering design course. Interview participants were selected from students who participated actively in the surveys throughout the course, oversampling from women and underrepresented minority populations. Because the focus of the larger study was on individual student perspectives, participants were recruited as individuals (rather than recruiting whole teams). In most cases, therefore, it was impossible to reconstruct different experiences from the same team or to connect student data to their teammates' data.

The thirty-one audio interviews were transcribed, and all interview transcripts were first read through in their entirety. Then, all instances where interviewees talked about team members and their relative contributions were excerpted from the transcripts. Students talked about the behavior of their teammates in response to questions including the following:

- How many people were on your team? Can you tell us about your teammates?
- For each of your teammates, please pick one to three cards to describe their role *[interviewees were given cards with the names of roles that team members may have taken on (Table 1)]*. If you don't think that there is a card that describes them, take a blank card and write one or two words that do. Tell us a bit about them.

Mechie	Planner	Helper	CAD Person	Eclectic
Finisher	Servo Person	Communicator	Idea Person	Scheduler
Artist	Shepherd	Builder	Cheerleader	Leader

Table 1. Team role cards provided in interviews

- Can you describe how your team usually made decisions?
- Could you tell me about a time when your team faced a challenge together and did well/poorly?
- Do you feel like your team trusted you with different types of tasks? Which tasks? How do you know?

Note that the questions asked about teaming behavior in general, not about positive or negative teaming behavior specifically. While most comments about teammates were positive or neutral, most interviewees (30 of 31 interviews) used negative language to describe at least one teammate without being explicitly asked. Individual segments of text where negative language or tone were detected were identified and compiled. These segments were then grouped by the type of concerns expressed. Eleven codes were identified that display the range of negative behaviors

described (Table 2). Complex phrases and ideas in the interview excerpts were coded with multiple codes, as appropriate.

Results

Table 2 details the eleven codes that emerged from the dataset. Every instance of negative language was classified with one to three codes, with each code occurring between five and twenty-four times in thirty-one interviews (Figure 1). These categories were created directly from the interview data and independently of other taxonomies of team contributions (which were not reviewed until after the codes and categories were created).

Emergent Codes	Definition	Example Quote(s)
Expecting too much from others	Expecting other teammates to contribute beyond their "fair share", especially to avoid responsibility themselves	*"Oh, well, you're not working on anything." I'd be like, "Well, I did my part already, so that's why I'm not working on it." And then they'd be like, "Well, can you pick up my slack and do what I was supposed to do?"*
Failing to advance toward project's completion	Passively failing to add value to activities that move the project forwards	*"She just didn't really contribute as much... I know she was in the machine shop a bit, except I don't think she actually machined anything."*
Failing to prioritize project	Demonstrating that other commitments take precedence over the project; often an unwillingness to devote time resources to the course	*"She was missing a lot of the time because...I think she was in a coding class and I know that's very time-intensive."*
Inconsistency of contribution	Exhibiting widely-varying contribution levels over the course of the project	*"He didn't really participate in anything in the beginning [of the semester], but he picked up towards the end."*
Inconsistency with an engineering identity	Possessing personality traits or performing activities that the interviewee deemed inconsistent with their vision of how an engineer should behave or feel	*"...she'll go do it and do a perfect job, things like that. But she doesn't care quite as much…"* *"She did a lot of non-engineering things that needed to happen …but what you did was a lot less work than what everyone else did."*
Lack of communication	Failing to disseminate information important to the group's effectiveness, or to connect with teammates in general	*"Often times he thinks of ideas and he just does it and then at the end he'll tell us about it."*

Table 2a: Emergent Categories

Emergent Codes	**Definition**	**Sample Quote(s)**
Lack of competence, experience or skills	Demonstrating a lack of understanding or ability necessary to complete a task	*"And then we'd get questions like, 'That doesn't make sense. That's not right,' and it would always be on the stuff that she did."*
Lack of initiative	Unwilling to take on tasks beyond clearly articulated expectations of teammates	*"He always put his work in, like, 'Hey give me something to do.' I'm, like, okay do this and then he'd do it and that was good but doesn't step up beyond that."*
Procrastination	Delaying the completion of tasks required for the project until absolutely necessary	*"And he also likes to—he's one of the people that likes to wait until the very last minute to do everything. Which is frustrating."*
Restricting others' work	Directly or indirectly inhibiting the group from completing its work in a timely manner	*"I would write some code and it worked fine and then ___ would come in, he doesn't like it for whatever reason, the style's bad or something, so he'd just, like, rewrite my code."*
Unreliability	Not trusted to follow through on tasks they promise to complete	*"Can't really trust him to get his work done in time... you're kind of wondering all this time is he getting it done or should I just do it myself."*

Table 2b: Emergent Categories

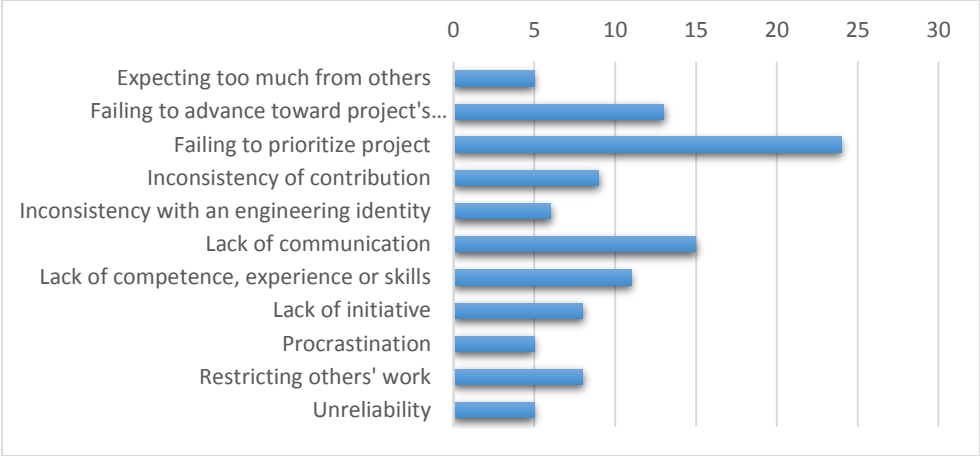

Figure 1: Instances of negative language use regarding teammates

Emergent Categories

While all of these themes reflect the interviewee's perceptions, that is especially the case in the "Expecting too much from others" category. This category primarily reflected a teammate's expectation that others on the team (such as the interviewee) should be willing to "pick up their slack", which can be perceived as controlling and manipulative. For example, one sophomore described a team leader who felt that "'I did all of this CAD so you guys do all this.' And then she never said please.'" Interviewees discussing this behavior often identified themselves as more competent than their peers, and resented that other students therefore expected them to do extra work. Another student's teammates responded to her request that they make some modifications with "actually, you could probably do it faster", which she described as "annoying". It should be noted that students often speak very positively about interdependence in their teams and the importance of relying on one another, so long as the contributions remained relatively equal. The complaints occurred when students felt that their teammates were taking advantage of this goodwill to avoid responsibility themselves.

"Failing to advance toward project's completion" refers to the "pushing" of a project through its stages to completion. The advancement of a project requires that its participants are actively engaged and taking value-added steps toward improving the project's current state. Participants spoke of idleness and of "just sitting watching everyone else do things". This theme emerged from participants acknowledging one peer's contributions in contrast to another's inactivity, concentrating on what a teammate did not accomplish.

"Failing to prioritize project" refers to teammates who always seem to have somewhere more important to be. These people tend to be described as overscheduled due to a heavy course load, extracurricular activities, demanding relationships, or a part-time job. Even if the peer describing them acknowledged that those other commitments were worthwhile, they often conveyed some bitterness that their shared project did not take precedence. This behavior was often excused on

the grounds of how, when the project became demanding (during "crunch time"), these students did tend to buckle down and regain their teammates' trust.

"Inconsistency of Contribution" reflects a lack of commitment to actively contributing uniformly throughout the entire length of the project. These students participated effectively towards the beginning of the course but drifted off towards the end, or they contributed minimally at the start of the course but participated in the final 'push' to completion. These shifts in effort may have resulted from a change in external factors. For example, a senior who received a job offer may have contributed towards the beginning of a course, but saw no reason to devote his or her time to its completion. Conversely, another student might not have felt pressure to work on a project at the beginning of a course, but that changed once deadlines loomed.

"Inconsistency with an Engineering Identity" included both personality traits that were felt to be unfavorable for an engineer working in teams (such as showing lack of enthusiasm for the project) and the interviewee's attitude that some project tasks (usually technical work) were more valuable than others (usually administrative work). For example, one student lamented that "I feel like my teammates it's more about getting an A on the project while asserting that to me engineering is kind of everything...I get a chance to do a design project, I'm going to go all in." Perhaps surprisingly, a bias towards technical over administrative work was only explicitly stated twice in thirty-one interviews.

Students who failed in the "Lack of communication" category tended to discount the importance of "being on the same page" as their teammates. These students may have made decisions without their teammates' knowledge or approval, or may simply not have been responsive to their teammates' attempts to reach consensus e.g. "Sometimes he would get off topic, and we'd just have to just kind of guide him back and focus him on the task at hand". Regardless of the particular context, these students struggled to communicate effectively with teammates.

If a teammate demonstrated a "Lack of competence, experience, or skills" deemed necessary to address a project's challenges, they were often described as being "behind" [in ability] relative to the rest of the group. Routine tasks were described as being difficult for these students. This resulted in their frequently asking peers to answer seemingly obvious questions, or providing inaccurate information to the team (prompting rework). Undoubtedly, these students are learning a great deal during the course. From the perspective of peers however, there was a sense that a student who lacked competence held the team back from focusing on the important issues.

The "Lack of initiative" category suggests that going "above and beyond" is the standard. Students expected their teammates to both take ownership over a portion of the project and to do more than their assigned workload. Students may be more likely to perceive that a teammate has contributed to the project if there is a concrete aspect of the project for which they were the

primary contributor. Furthermore, a team cannot exhaustively outline the tasks that need to be completed. Thus, doing your "fair share" requires taking the next step. A team member who only completed the activities explicitly assigned to him or her was frequently deemed unacceptable by the group (eight occurrences in the interviews).

Students who fulfilled their obligations, but not until the last moment, were reflected in "Procrastination". Even if those members of the team thrived under the pressure of a pre-deadline time crunch, the tactic often proved stressful to other teammates, particularly those who preferred to finish tasks far in advance. Dependencies in a project meant that students sometimes couldn't complete their component in a timely fashion because a teammate was procrastinating on their components.

Students falling in the category of "Restricting others' work" are perhaps the opposite of the "slacker". They may have been overly critical of their teammates' work, either demanding that it be redone (slowing down the process) or redoing it themselves. Some team members were described as being so convinced that their own ideas were correct that they manipulated the rest of the team's decisions, not allowing other voices to be heard. One student commented: "Anybody can write, you know, 1000 lines of code, but if it breaks…or doesn't keep to the abstractions that you defined with your team, then you're not actually helping, you're hurting". According to their peers, these behaviors actively detracted from the work's quality and made it harder to complete the project on time.

The behavior of students who demonstrated issues of "Unreliability" frequently did not follow through with their promises. When a teammate was perceived to be unreliable, their peers reported that, in addition to their own work, they felt compelled to track the progress of their unreliable teammate and to continually remind that person of their obligations. This, together with not trusting that the assignment would be completed (or completed satisfactorily), led to increased tension among the peers of the teammate perceived as unreliable.

Discussion

In this study, we used responses to a semi-structured interview about teaming experiences to investigate the negative experiences that engineering students have with their teammates. From these responses, eleven categories of negative behavioral components emerged, rooted directly in the experiences of students. These categories were compared to Baker's previously identified categories of positive behavioral components in teaming, and were also investigated for how they related to different types of motivation.

Positive vs Negative Peer Feedback:

Six of the eleven negative categories that emerged from the qualitative analysis of student interviews map to the positive basic behavioral components that Baker identified in her meta-analysis of peer assessment tools,[2] but some new behavioral components were observed (Table 3).

Meta-analysis of behavioral components[2] (Positive)	**Emergent Categories (Negative)**
Attended group meetings; was available and on time	Failing to prioritize project
Submitted quality work	Lack of competence, experience, or skills
Exerted effort and took an active role	Failing to advance toward project's completion; Lack of initiative
Cooperated and communicated with others	Lack of communication
Managed group conflict	
Made cognitive contributions; possessed and applied necessary knowledge and skills	Lack of competence, experience, or skills
Provided structure for goal achievement	
Was dependable, kept his or her word	Unreliability, Procrastination, Inconsistency of contribution
	Expecting too much from others
	Inconsistency with an engineering identity
	Restricting the work of others

Table 3: Comparisons between positive behavioral components and negative emergent categories

Two positive behavioral components do not have negative counterparts: managed group conflict and provided structure for goal achievement. Three negative behavioral components do not have positive counterparts in Baker's categories: expecting too much from others, inconsistency with an engineering identity, and restricting the work of others. Here, we focus on these novel

negative behavioral components in the hope that they will provide new insights into the student teaming experiences (as well as ways to improve it).

It is understandable that the "expecting too much from others" and "restricting the work of others" categories are not included in educator-designed surveys. From the perspective of instructors aiming to make students highly accountable for their own learning within a group, having high expectations of teammates should be a positive aspect of project work. Likewise, redoing the work of others is favorable if it produces a better final product. However, the students themselves experience these behaviors as negative, perceiving it as controlling or devaluing their contribution.

Comments indicating behavior that demonstrated "Inconsistency with an engineering identity" appeared in the interviews six times (Figure 1), but only two of these were instances in which administrative tasks were viewed as inferior to more technical "engineering" tasks. The low occurrence suggests that this particular view is not a major factor in the negative perception of teammates. These comments are more revealing of an interviewee who fails to recognize that all tasks necessary to organize and carry out an engineering project have value. More prevalent within this category were students expressing the concern that their classmates were not as intrinsically motivated by engineering in general as they themselves were.

The average number of negative comments per interview grew from 2.7 instances among first-years to 3.8 among sophomores, and 4.1 among seniors. The category that was most frequently observed among the negative comments overall was "Failure to prioritize the project", with "Lack of communication" coming in second (Figure 1). "Failure to prioritize the project" comprised 13% of the negative comments among first-years, 26% among sophomores, and 24% among seniors. The corresponding codes of these comments appeared to evolve over the four-year program, however, with the proportion of "Communication" and "Failure to prioritize project" comments rising (10% to 24.2% and 13.3% to 26.1%, respectively) from the first year to the senior year, while concerns about unreliability over the same period dropped from 6.5% to 0%. This may reflect a greater need for communication among students preparing to graduate, or it may reflect their growing awareness of communication as a crucial skill for entry-level technical employees[1].

Negative behavior components and motivation

There is a widespread tendency to focus on developing good teaming behavior by focusing on the positive components. Students that don't fully engage with the team are often described as "freeloaders" or having "checked out". Self-determination theory and its models of motivation—in particular, that being "unmotivated" is not an inherent quality but rather is highly contingent

on circumstances—can illuminate these negative behaviors and possibly provide paths for intervention and understanding.

A number of the categories discussed here, such as displaying initiative, taking responsibility for one's own work and not expecting others to pick up one's slack, and actively working to propel the project forward, require first embracing the three elements of intrinsic motivation: autonomy, relatedness (interdependence), and personal competency. If extrinsically motivated, students are more likely to feel coerced into action (rather than autonomously choosing the action) and do only the bare minimum to receive the promised reward, such as a good grade. The motivation in play largely depends on external factors. We can therefore ask what aspects of the learning environment in which these students are situated emphasize one type of motivation over the other. When we come across students who are perceived to be displaying amotivation or extrinsic motivation, we can investigate: is it because they are uninterested in the project topic, uninvested in the community, or unclear on the next steps to take?

Broader Themes

We propose that the negative teaming behaviors identified can be placed on an axis ranging from complete inactivity (non-contribution) to active inhibition of the project (Figure 2). Major points along this spectrum include "Failing to advance project to completion" representing close to total inactivity, "Restricting others' work" representing near total active inhibition of the project, and "Inconsistency of contribution", situated between the other two. "Failing to advance project to completion" indicates instances in which a teammate simply fails to contribute at any level. These students may be "checked out" and seem uninterested in both the project itself and its outcome, suggesting amotivation. On the opposite end of the spectrum, "Restricting others' work" refers to active inhibition of the project's ultimate success. In some sense, these are self-sabotaging behaviors, such as refusing to consider anyone else's ideas or rewriting already-functioning code. "Inconsistency of contribution" sits in the middle of the activity spectrum and demonstrates that both effective and ineffective behaviors can be seen in the same person. In these cases, interviewees distinguish between time periods the target was deemed acceptable and those when the target's work was absent or subpar.

This research is meant to help understand not just ways in which teammates are dissatisfied with each other's work, but more broadly, their motivations for failing to participate effectively, using the framework of self-determination theory. It may be that students whose activities fall towards the 'inactivity' end of the spectrum struggle with amotivation, a state in which one cannot see the connection between actions and outcomes. This type of motivation maps to the low end of performance quality.[17] In this context, this means these students may not see how their contributions can add value to the project, or may feel that the work of their teammates is sufficient for the project's successful completion. Thus, they fail to apply themselves to work on

the project at all. In contrast, the behavior of students at the "activity" end of the spectrum may manifest as controlling behavior, even to the extent of actively inhibiting their teammates' work. This may be driven by mistrust or fear of failure, leading to strained team dynamics. Though different types of motivation may be present in the same person,[17] these behaviors may be consistent with extrinsic motivation, such as fear of getting a poor grade.

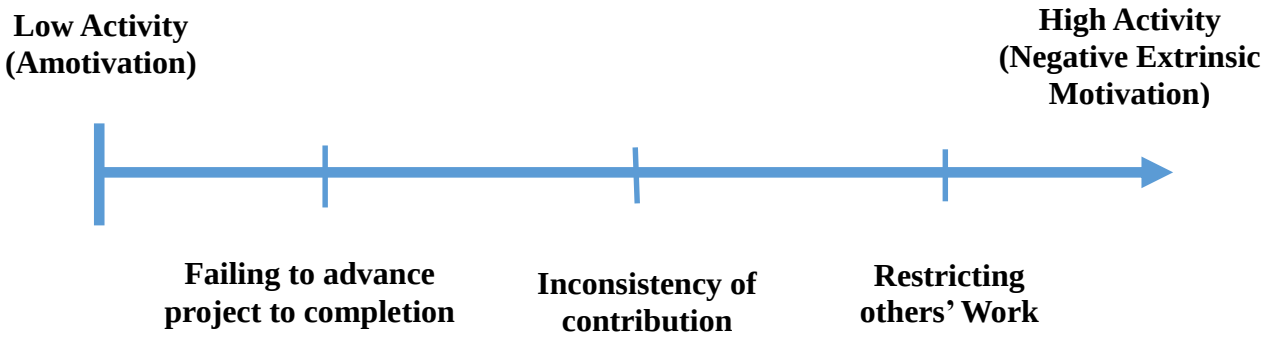

Figure 2: Negative behavioral components mapped to activity level spectrum

Conclusions

Much work remains to be done in understanding the motivations of non-contributors and peer-to-peer dynamics in student teams. This data in particular could be connected to the demographics of the interviewees and the teammates described to better understand the nature of the judgments made. Thomas-Hunt and Phillips have observed that "the complexity of most organizational tasks makes it difficult for expert members to demonstrate the correctness of their perspective prior to the completion of the group's task and the receipt of feedback from sources external to the group. Consequently, teams often have difficulty assessing the veracity of members' claims of expertise."[21] This suggests that these claims, and how they are assessed, are particularly likely to be colored by implicit bias, such as the perception that women are less capable of engineering work, which leads to further research questions: Do the types of complaints made correspond to the non-contributors' actual attributes or to implicit biases, or do they correspond more closely with the attributes of the student who is describing their teammates? Furthermore, some evidence suggests that whether or not a teammate's expertise is recognized depends mostly on the actor's (judger's), personal attributes and identifications, rather than the characteristics the target (judged) possesses.[11] If the failure to recognize expertise is driven by the judger's personal characteristics, we may also see certain groups systematically rated as contributing less than their peers. These types of findings may provide additional insight into the motivations of the perceived non-contributors. Because the interviews here focused on the interviewee's experience, information about the identity and demographics of their teammates was not

collected, but would certainly be of interest for future work. Similarly, a more team-based approach could provide more information about negative teaming experiences. Did all teammates agree on who contributes effectively and who does not? Is there a divide in perceived contributions based on the identity of each team member?

Understanding the motivations of student behavior within a teaming environment may have implications for improving student persistence in engineering, especially among underrepresented groups. Students leave engineering programs in large part because they feel alienated from the engineering community.[13] A marked difference exists between the classroom, in which subject knowledge alone suffices, and a project environment, in which students must exhibit the "inter-relationships of knowledge, practice, and identity"[3] and be socially recognized.[14] Danielak *et al.* note that "learners' perceptions of which practices constitute knowing and performing in a discipline can link to their identification or what we term *disidentification* with the discipline".[7] Further research may reveal whether negative behaviors stemming from particular types of motivations (Figure 2) have an effect on student persistence in engineering.

From our qualitative analysis of interviews addressing teaming behavior, we observed that the students in our sample primarily described teammates in positive or neutral terms. However, focusing on negative comments allowed us to broaden our understanding of student experiences on teams. In particular, some categories of negative teaming experiences did not map to positive ones, suggesting that they aren't captured by widely used peer assessment techniques. A richer understanding of negative behaviors, when viewed through the lens of understanding motivation, provides educators with the opportunity to improve teaming experiences, particularly of students who are perceived as negatively affecting the team's function and of their teammates.

Acknowledgments

We would like to thank our research group, including Teri LaForest, Tyler Lindow, and Anna Render, for their insightful discussion of the coding scheme outlined in this paper, as well as for their support throughout this project. We are grateful for support provided by the National Science Foundation, in the form of a CAREER grant to Debbie Chachra (EEC- 0953698) and a Research Experiences for Undergraduates grant which supported a summer program at Olin College of Engineering (DUE-1156832). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

References

1. Aasheim, Cheryl L., Susan R. Williams. 2009. "Knowledge and Skill Requirements for Entry-Level Information Technology Workers: Do Employers in the IT Industry View These Differently than Employers in Other Industries?." . Department of Information Technology Faculty Research and Publications, Paper 1.

2. Baker, Diane F. "Peer Assessment in Small Groups: A Comparison of Methods." Journal of Management Education 32.2 (2008): 183-209.

3. Boaler, J. (2002). The development of disciplinary relationshps: Knowledge, practice and identity in mathematics classrooms. *For the Learning of Mathematics*, 22(1), 42-47.

4. Chalupa, M. R., Chen, C.S., & Sormunen-Jones, C. (2000). Reliability and validity of the group member rating form. The Delta Pi Epsilon Journal, 42(4), 83-88.

5. Chickering, A.W., and Gamson, Z.F. (1991). Applying the Seven Principles for Good Practice in Undergraduate Education. New Directions for Teaching and Learning. Number 47, Fall 1991. San Francisco: Jossey-Bass Inc.

6. "CRITERIA FOR ACCREDITING ENGINEERING PROGRAMS, 2016 – 2017." ABET. < http://www.abet.org/accreditation/> Accessed April 2016.

7. Danielak, Brian A., Ayush Gupta, and Andrew Elby. "Marginalized Identities of Sense-Makers: Reframing Engineering Student Retention." *Journal of Engineering Education* 103.1 (2014): 8-44.

8. Deci, Edward L. *Why We Do What We Do: Understanding Self-Motivation*. New York: Penguins, 1996. Print.

9. Erez, A., Lepine, J. A., & Elms, H. (2002). Effects of rotated leadership and peer evaluation on the functioning and effectiveness of self-managed teams: A quasi-experiment. *Personnel Psychology*, 55, 929-948.

10. Gueldenzoph, Lisa E. "Collaborative Peer Evaluation: Best Practices for Group Member Assessments." *Business Communication Quarterly* 65.1 (2002): 9-20.

11. Joshi, Aparna. "By Whom and When Is Women's Expertise Recognized? The Interactive Effects of Gender and Education in Science and Engineering Teams." *Administrative Science Quarterly* (2014): 202-39.

12. Kane, Jeffrey S., and Edward E. Lawler, III. "Methods of Peer Assessment." *Psychological Bulletin* 85.3 (1978): 555-86.

13. Marra, R. M., Rodgers, K. A., Shen, D., & Bogue, B. (2012). Leaving engineering: A multi-year single institution study. *Journal of Engineering Education*, 101(1), 6-27.

14. Nasir, N.S., & Hand, V. (2008). From the court to the classroom: Opportunities for engagement, learning, and identity in basketball and classroom mathematics. *Journal of the Learning Sciences*, 17(2), 143-179.

15. Pereira, Anna, Michele Miller, William Helton, Leonard Bohmann, and Chris VanArsdale. "An Examination of Industry's Desired Traits for Engineering Graduates and Gender Differences." *Proceedings of the American Society for Engineering Education Annual Conference*, 2010, Louisville, KY.

16. Prince, Michael. "Does Active Learning Work? A Review of the Research." *Journal of Engineering Education* (2004): 223-31.

17. Ratelle, Catherine F., Frederic Guay, Robert J. Vallerand, Simon Larose, and Caroline Senecal. "Autonomous, Controlled, and Amotivated Types of Academic Motivation: A Person-Oriented Analysis." *Journal of Educational Psychology* 99 (2007): 734-46. ,

18. Ryan, Richard M., and Edward L. Deci. "Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions." *Contemporary Educational Psychology* 25 (2000): 54-67.

19. Sonnentag, Sabine, and Judith Volmer. "Individual-Level Predictors of Task-Related Teamwork Processes." *Group & Organization Management* 34.1 (2009): 37-66.

20. Stewart, Greg L., Ingrid S. Fulmer, and Murray R. Barrick. "An Exploration of Member Roles as a Multilevel Linking Mechanism for Individual Traits and Team Outcomes." *Personnel Psychology* (2005): 343-65.

21. Thomas-Hunt, Melissa C., and Katherine W. Phillips. "When What You Know Is Not Enough: Expertise and Gender Dynamics in Task Groups." *Personality and Social Psychology Bulletin* 30.12 (2004): 1585-1598.

22. Zhang, Aimao. "Peer Assessment of Soft Skills and Hard Skills." *Journal of Information Technology Education: Research* 11 (2012): 155-68.