Full Paper: An Investigation of Team Conflicts in a Large-Enrollment Introductory Engineering Course

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Introduction

Team-based projects are widely used in introductory engineering courses to support the development of collaboration and communication skills and engage the novice engineer in higher levels of thinking. Conflicts within student teams are common, especially in the first year, where students frequently have had limited experience working on substantial projects that require contribution from all team members. Ohland et al. have developed a robust peer evaluation system (Comprehensive Assessment of Team Member Effectiveness: CATME by Purdue University) that is widely used in engineering programs—including our institution—to collect quantitative and qualitative information that can be used to individuate student performance within teams [1]. To effectively address interpersonal issues in teams, it is important to detect the incidence and root cause of team conflicts.

This paper investigates the prevalence of team conflicts in a large-enrollment introductory engineering course. Using weekly CATME peer evaluation data, end-of-semester student polls, and final scores in the course, this study characterizes the type and incidences of team conflicts. Results indicate that "social loafing"—tendency for individuals to expend less effort when working collectively than when working individually—is a dominant issue, which has been identified in previous studies as the most prevalent problem within student teams [2].

Study Setting and Methods

The study setting is an introductory engineering course at University of Delaware, a mid-sized, research-intensive state university in the US. The course is taken in the first semester (fall) by all incoming engineering students across all majors. The course is taught in two identical, large-enrollment sections of ca. 350 students per section with additional instructional help from undergraduate TAs called peer leaders [3]. From 2016-2019, the course was offered face-to-face with twice weekly 60 minutes of lecture and active learning exercises in a large auditorium [4]. In Fall 2020, due to the COVID-19 pandemic, the course was offered in an entirely online format with asynchronous lectures [5]. In Fall 2021, the course followed a hybrid model with asynchronous online lectures and in-person small group discussion sections led by peer leaders. Student demographics have remained largely consistent—ca. 30% female, 20% historically underrepresented, and 95% being first-time freshmen matriculating directly from high school.

The course is structured around multi-week, team-based projects that are scaffolded by weekly team assignments. Students were manually assigned to teams of 4-6 individuals and remained in the same team for the duration of the semester. Teams were formed to target a mixture of majors without isolating women or underrepresented minorities within a team. Team-based assessments constituted 80% of the course grade, and students were required to complete weekly peer evaluations using CATME [1]. The CATME survey results were not shared with the students and were only visible to the instructional team. Each peer leader was assigned an average of five student teams to mentor; the peer leaders used the weekly CATME peer-evaluations to individuate contributions within the team submissions. In Fall 2021, the total student enrollment of 651 were divided into 134 teams.

To investigate the prevalence of team conflicts, two sets of data were used: 1) three sets of CATME Peer-Evaluation surveys (two activities and a project report) from the most recent offering of the course in Fall 2021, and 2) student responses to polls on their team experience during the last lecture of the course over the past three course offerings (Fall 2019: face-to-face modality, Fall 2020: online modality, and Fall 2021: hybrid modality). All assignments analyzed for this study were connected to a project where students designed mechanical models composed of parts laser-cut from thin sheets of wood [6]. Details of these two data sets are shown in Table 1. Overall response rates in both data sets were high enough to be representative. Additionally, final scores of the Fall 2021 cohort were used to analyze student performance in the course.

Table 1. Data sets used to evaluate type and incidence of team conflicts.

Type of Data	Data Set	Details	Response Rate
CATME Peer-Evaluation Surveys from Fall 2021	**Assignment Name**	**Week Due**	
	Activity A3	Week 4	83% (of 651)
	Activity A6	Week 9	88% (of 651)
	Project 1 Report	Week 15	78% (of 651)
Student Poll Responses at End of Semester	**Course Offering**	**Mechanism**	
	Fall 2019 (face-to-face)	iClicker responses	67% (of 725)
	Fall 2020 (online)	Zoom poll	62% (of 651)
	Fall 2021 (hybrid)	Zoom poll	69% (of 651)

In CATME Peer-Evaluation surveys, students rate each other from 1 to 5 (5 is highest) in five areas: 1) contributing to the team's work, 2) interacting with teammates, 3) keeping the team on track, 4) expecting quality, and 5) having relevant knowledge, skills, and abilities [1]. CATME computes the ratio of each student's score to the average team score to give each student an "adjustment factor" that can used to score the student's ratings [1]. This study uses students' adjustment factor without self that excludes their self-rating during the calculations [7]. An adjustment factor of 1 represents 100% score. If a student received an adjustment factor of less than 0.8, their individual score in the assignment was lowered by 10-20%.

For this analysis, students were flagged if they received a CATME "exceptional condition" that indicated a team issue. These exceptional conditions include: low performer (overall rating less than 2.5), overconfident (overall rating less than 3 but rated themselves a full point or more higher), manipulator (gave themselves high ratings while rating other members poorly), conflict (rated someone as 2 or less while median rating from the rest of the team is 3 or more), and cliques (significant disagreement between ratings indicating team split) [7]. Additionally, a student without any exceptional condition was flagged if they had an adjustment factor (without self) less than 0.8, indicating a poor performance. These flags are called "CATME flags" in this paper. Activities A3 and A6 were chosen for this analysis as they represented significant milestones towards the project. The project report was a comprehensive report on this project.

The end-of-semester polls contained four questions relating to team dynamics. Students responded to four common reasons for interpersonal conflicts in their teams: (i) different levels of experience with subject matter, (ii) different expectations for success/grade in the course, (iii) one or more dominating team members, and (iv) one or more "slacker" team members. Student

choices for a response were: Definitely a factor, Possibly a factor, Not a factor, or Did not experience conflict. The same poll questions were used across all years analyzed in this study.

Results

CATME Peer-Evaluation Surveys

Figure 1 shows the number of teams that had zero, one, two, or three assignments with at least one member receiving a CATME flag. Across the three assignments, over half of the 134 teams did not have any members with CATME flags across all three assignments analyzed in this study. Eight teams had CATME flags across all three assignments. Note that a team with one, two, or three assignments with CATME flags may have had multiple team members with CATME flags in each assignment.
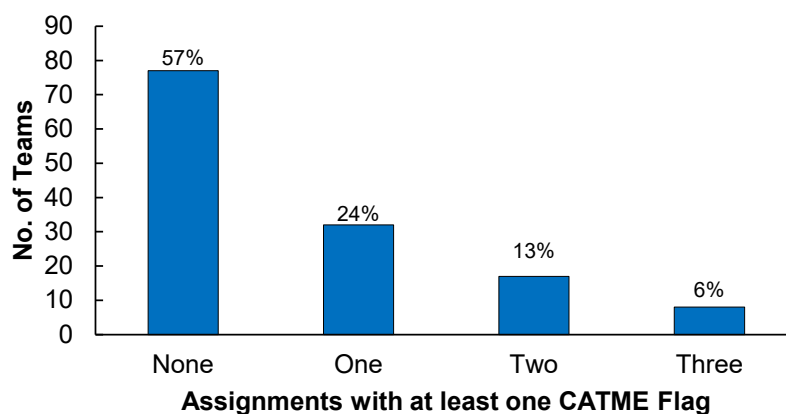

Figure 1: Distribution of teams based on number of flags in their CATME peer-evaluation surveys for three different assignments staggered across the semester in Fall 2021 (Activity A3, Activity A6, and Project 1 Report; total 134 teams).

Figure 2 shows the number of teams with each type of CATME flags in each of the three assignments. Some teams had multiple students flagged in each assignment; the total number of unique teams with flags for each assignment is denoted. The number of teams with CATME flags increased with time—15% of teams from week 4 of the semester to 32% of teams in week 15—indicating a rise in team issues as the semester progressed.

As described before, CATME flags include some "exceptional conditions" that CATME detects automatically as well as students who were manually flagged for an adjustment factor less than 0.8 ("Other adj. factor < 0.8" in Figure 2). The most common CATME flag is adjustment factor < 0.8, followed by "Conflict", where the flagged student rated someone significantly lower than other members' ratings for that person. "Overconfident" was the next most frequent CATME flag, where students rated themselves higher than their ratings from their teammates. "Low Performer", where students had an overall rating less than 2.5 ranked next in frequency of occurrence; early in the semester (Activity A3 in week 4) there were no students with this CATME flag. "Manipulator" and "Cliques" had overall low incidence rates.
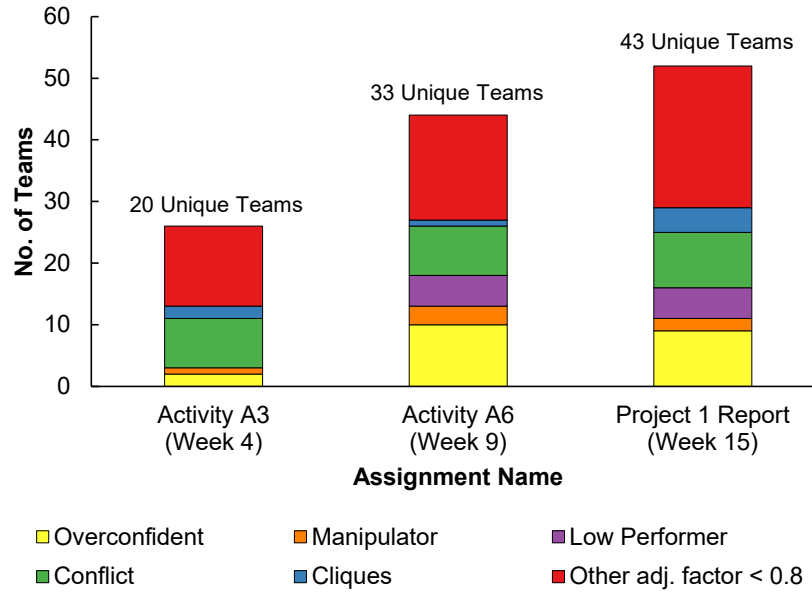
Figure 2. Distribution of the six different types of CATME flags among 134 teams in Fall 2021 for each of the three assignments analyzed in this study.

Figure 3 shows box and whisker plots of final score (out of 100) of all 651 students in Fall 2021 categorized by the CATME flags they received in Project 1 Report. 88% of the students did not have a CATME flag (n = 575; mean = 93.6). Final scores of students flagged as "Low Performer" had a wide range and were generally lower than students with other CATME flags (n = 5; mean = 59.4). Students flagged manually for having an adjustment factor < 0.8 did better than the "Low Performer" category (n = 30; mean = 83.5) and performed similar to students flagged as "Overconfident" (n = 9; mean = 85.3). "Manipulator" flag was rare (n = 2), with both students with this flag receiving high final scores. For all other CATME flag categories, students with CATME flags performed similar to students with no flags.
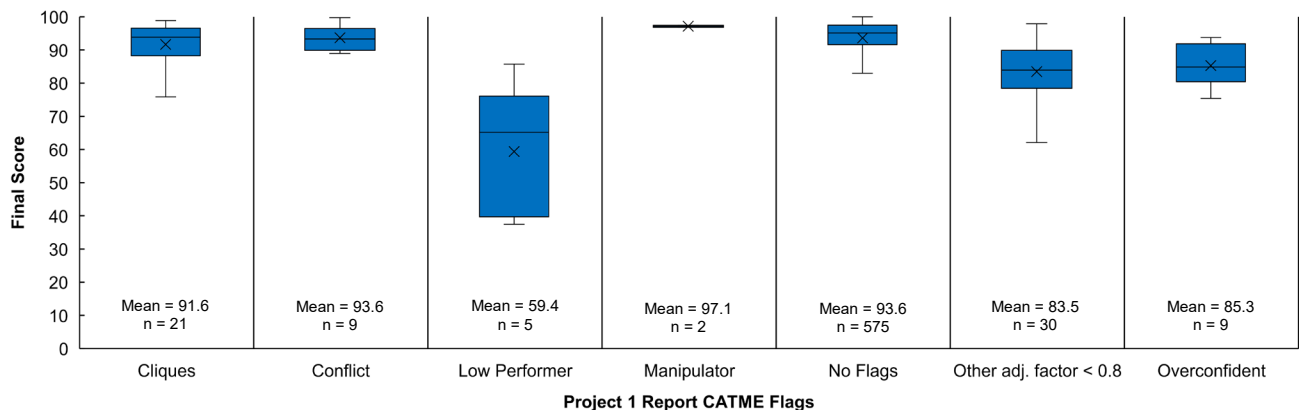

Figure 3. Distribution of final course scores for all students in Fall 2021 (651 students) categorized by CATME flags they received in Project 1 Report. Number of students and mean final score for each CATME flag category are reported.

End-of-Semester Student Polls

Figure 4 shows student responses over the past three course offerings to the same end-of-semester feedback poll relating to their perceptions of team discord. Across all course modalities, the presence of "slacker" team member(s) dominates as a reason for interpersonal conflicts. In Fall 2021, on average, 35% of students indicated that they did not experience conflict. In contrast, only 32% of student teams had CATME flags for Project 1 report at the end of the semester (Figure 2). Thus, CATME peer-evaluations may not be fully capturing all interpersonal conflicts in these student teams.
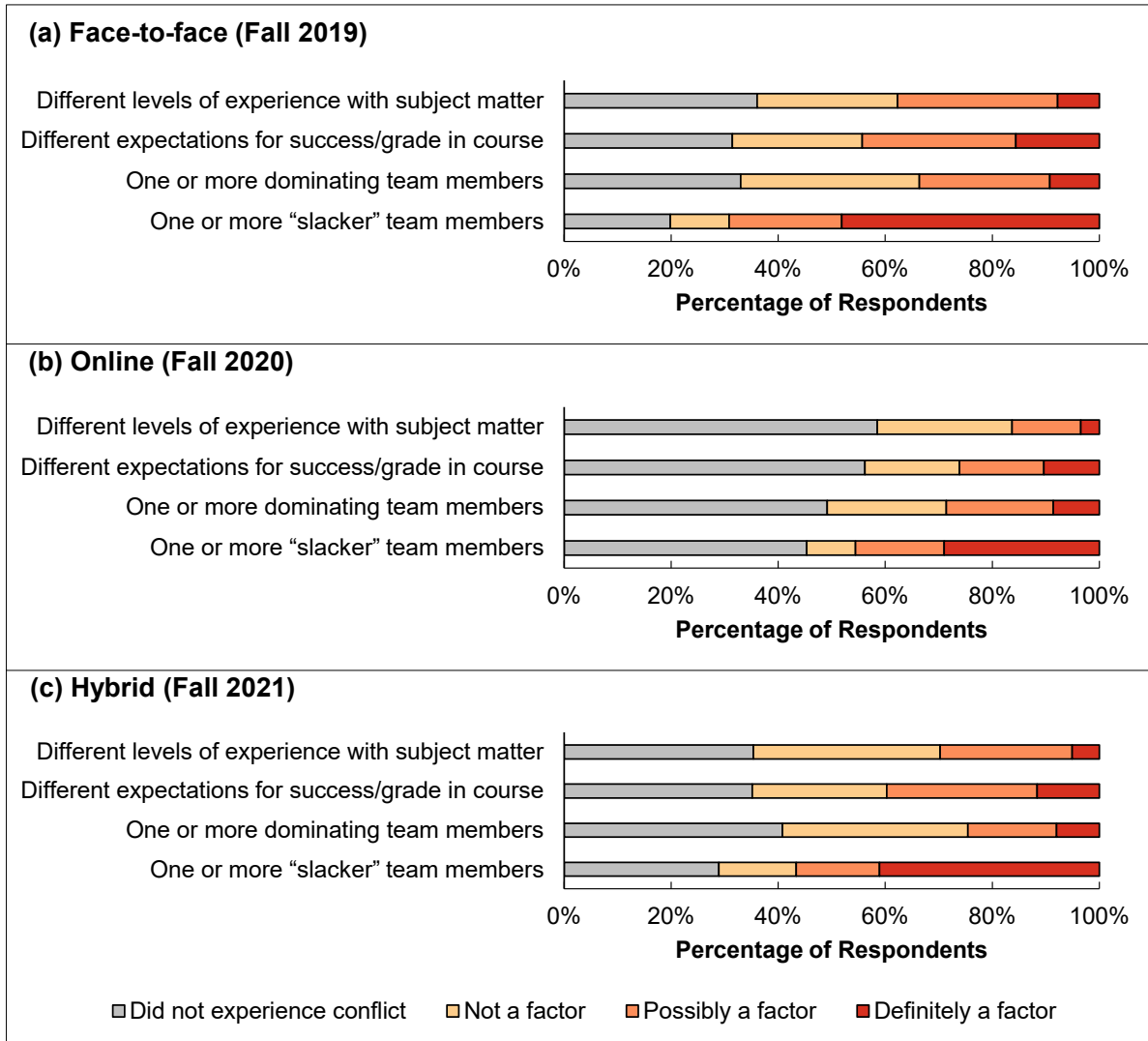

Figure 4. Student responses to the question, "How much, if any, interpersonal conflict occurred within your team due to…" over the past three course offerings: (a) Fall 2019 (face-to-face), (b) Fall 2020 (fully online), and (c) Fall 2021 (hybrid).

It is of note that a higher percentage of students in the fully online modality (Fall 2020) reported that they did not experience interpersonal team conflicts compared with the face-to-face (Fall 2019) and hybrid (Fall 2021) modalities, which involved in-person interactions among teams.

Summary, Conclusions and Future Work

This study analyzed CATME Peer-Evaluation surveys from three assignments that were staggered through a semester-long team project. The study also compared student perceptions on team conflicts across the past three years where the course has been offered in different modalities (face-to-face, fully online, and hybrid) with largely the same course structure.

In Fall 2021, 8 out of 134 student teams had at least one team member with a CATME flag in all three assignments, showing evidence of persistent team issues. Students with CATME flags of "Low Performer", "Overconfident", and "Other adjustment factor < 0.8" have reduced performance in their teams and have lower final course scores. Over different course modalities, students identified the presence of "slacker" team members as the predominant reason for team conflicts. This indicates that social loafing is prevalent among student teams. In previous work by the authors, undergraduate TAs in this course also reported struggles with social loafing among their mentees [3]. There are indications that CATME peer evaluations may not fully capture all team conflicts experienced by students in this course. Future work will focus on understanding the root cause of social loafing and other types of team conflicts. The aim is to develop tools to detect team conflicts early and coach individuals and teams towards effective team behaviors.

References

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