Perceived Benefits and Drawbacks of Group Assignment Methods

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Abstract

Many undergraduate engineering courses include laboratory work where students are asked to work in pairs or groups to complete assignments. Group work can offer many benefits including improved communication and team work skills, appreciation and respect for others, and even increased individual performance. However, group work may also present drawbacks including ostracism, unequal work distribution (some group members not 'pulling their own weight') and decreased individual performance. When creating groups, instructors are faced with deciding whether to allow students to form their own groups or to assign them, whether to change groups weekly or keep them the same all quarter (or semester) and whether to require students to submit their work individually or as a group. This paper explores the effects of the method of group assignment on the benefits and drawbacks of group work as perceived by students. Specifically, the paper presents the results of a group assignment survey given to students in several undergraduate computer engineering courses that span sophomore to senior level and are taught by different faculty.

Introduction

Group work is an important aspect of any undergraduate engineering program. The Accreditation Board of Engineering and Technology (ABET) states that all ABET accredited programs should give students "an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks and meet objectives" [1]. Educational research has shown that group work has a significant impact on long-term material retention, critical thinking and communication skills. Group work can also increase individual productivity and performance (a student can achieve more than working on their own), skills development (interpersonal, leadership, motivational), and knowledge about the self (identifying strengths and weaknesses) [2]–[4].

Although group work has many benefits, in the worst case, it can also present many challenges including ostracism (some members may feel like an outcast in a group), unequal work distribution (some members may not contribute), interpersonal conflict between team members (arising from differences in opinion and levels of contribution), and tardiness on deliverables (if no one is held accountable for completing work on time or if making decisions take too long for the sake of finding a consensus) [5], [6].

One aspect that can have a major effect on the success or failure of groups is how a group is formed. In the classroom, groups can either be formed through instructor assignment or student selection. Instructor assigned groups can be created randomly or through specific criteria to attempt to distribute student characteristics and group member resources. Online tools even exist to allow instructors to input the desired criteria, such as GPA distributions and level of diversity, on which to select groups [7].

Prior research has shown that student selected groups often yield a more harmonious experience (because students often select to work with people they already know), whereas instructor assigned groups are more likely to present social, communication, and organizational challenges [8]. However, instructor assigned groups can often be more task oriented and more successful at completing group assignments since self-selected groups of friends may spend more time off-task discussing extracurricular issues [9]. Further, prior studies have indicated that self-selected groups may be more appropriate for upper-division courses where students already know one another and know how to work well together [5], whereas instructor assigned groups may be more appropriate for lower division courses to insure that all students do not feel the social pressure to join with friends [10] and shy students or students from historically excluded identities do not feel left out or isolated [11].

In addition to group formation, instructors are also responsible for setting the lifetime of groups. They have the choice of keeping the same groups for the entire course or rotating groups throughout the semester/quarter. The choice to rotate or not can be constrained by the type of group assignment (e.g. semester/quarter long capstone projects often require a single team), but in courses where rotations are possible, rotations allow students to get to know more people in the class which can help them feel more comfortable among their cohort.

With a rotation system, students know that if they are in a group that does not work well together, they will only remain in that group for a short amount of time [12]. Also, each time a new group is formed, students have to spend time getting to know one another and working out team logistics (who is available to meet when, what skill sets does each person have, etc.). Both of these dynamics have benefits and drawbacks, although the authors have observed that in extreme cases, frequent rotations can allow certain students to be passed from one group to the next, relying on new partners to complete the entire assignment.

Finally, instructors have the option of attempting to reap the benefits of group work without explicitly assigning groups. In one study, a professor allowed students to form informal collaborations (rather than formal groups) to get help or assistance on an assignment, but ultimately required students to complete the assignments individually. Being responsible for each assignment helped the students learn the material better while at the same time gaining teamwork experience through informal collaborations [5].

In this paper, we explore the benefits and drawbacks of different group assignment methods by examining the group assignment methods used by four different computer engineering professors across four different classes that span 100 to 400 level courses. We describe the methods used to analyze the benefits and drawbacks of each group assignment method, present our findings, and conclude with a discussion of which group assignment method may work best for different course levels, and potential limitations of our results.

Methods

The authors of this paper each taught one to three undergraduate computer engineering studio courses (courses that combine lecture and lab in one class setting) in Fall 2018. Each of these courses included group work of 2–4 students for laboratory and/or project assignments. The four instructors independently selected different group assignment methods based on their personal preferences and experiences (see Table 1). The two instructors who taught CPE133 (a course that has weekly laboratory assignments) both chose to assign groups randomly and rotate groups each week to ensure that students had a chance to work with people of different abilities and backgrounds. They differed from each other in that one instructor still required individual submissions for assignments while the other required a single group submission. The two instructors of the 200, 300, and 400 level courses both chose to allow students to select their own groups, keep the same group for the whole course, and turn in assignments as a group. In the 200 and 300 level courses, the weekly projects are naturally progressive and build off each other or use previously written code. Rotating groups could pose an unfair challenge for students with limited time to complete new assignments as they try to learn and adapt previous assignments they did not work on themselves. In the 400 level course (a technical elective course), students were responsible for selecting and completing a single course-long group project.

Table 1: Group Assignment Methods used in Study Courses

Class Identifier	Class	Instructor	Number of Students	Student Selected vs. Instructor Assigned	Rotation vs. same group all term	Group vs. Individual lab submission
1	CPE 133	Instructor1	64*	Instructor Assigned	Rotation	Individual
2	CPE 133	Instructor2	21	Instructor Assigned	Rotation	Group

Class Identifier	Class	Instructor	Number of Students	Student Selected vs. Instructor Assigned	Rotation vs. same group all term	Group vs. Individual lab submission
3	CPE 233	Instructor3	57*	Student Selected	Same group all term	Group
4	CPE 329	Instructor3	31	Student Selected	Same group all term	Group
5	CPE 439	Instructor4	30	Student Selected	Same group all term	Group

*Two sections of the same course

To analyze the benefits and drawbacks of these different group assignment methods, we distributed an Institutional Review Board (IRB) approved survey to all students enrolled in the undergraduate courses taught by the four authors in Fall 2018. Students completed the survey in January 2019 (after the completion of their Fall 2018 courses) so that they could holistically reflect on the benefits and drawbacks of the group assignment method used in the previous term. The survey, distributed as a Google Form, consisted of multiple Likert scale questions [13] (1–Strongly Disagree, 2–Disagree, 3–Neutral, 4–Agree, 5–Strongly Agree) to gauge whether the group assignment method helped them achieve mastery of the material and a sense of comradery within the class. Figure 1 shows the questions used to analyze mastery of material and comradery respectively.

Based on the group assignment method used in your course, please indicate your level of agreement with the following statements:

Mastery:

- I learned how to use the hardware and software tools in this course
- I played a key role in each lab/project assignment
- The group assignment method contributed to my success in this course
- I feel confident in my ability to write a lab/design report
- I pulled my fair share of work

Comradery:

- *My groupmate(s) were a distraction or to completing the assignments
- I got to know other people in my class
- *I felt ostracized by my lab group
- I felt a kinship toward other students in my class
- I felt heard and respected by my peers
- *I would have preferred to work by myself
- If I did not understand why a solution worked, I asked my group member to explain it to me

*Questions where a disagreeing response is considered positive

Figure 1. Survey Questions for Group Assignment Study

The survey also asked students whether they would have preferred a different group assignment method in their course and included open ended questions about the benefits and drawbacks of the group assignment method used. The survey concluded with a few multiple choice questions asking about what group assignment methods they generally prefer in undergraduate engineering courses.

Findings

Table 2 below illustrates the population of survey respondents. To compute the average year in school, we asked students how many years (including the 2018-2019 academic year) they have been at Cal Poly San Luis Obispo and then asked if they were a transfer student. If the student indicated that they were a transfer student, an additional year was added to their answer before computing the average.

Table 2. Population of Survey respondents.

Class Identifier	Course Number	Instructor	Total # Respondents	Response Rate	Average Year in School	%Female Respondents
1	CPE 133	1	22	34%	2.16	37%
2	CPE 133	2	7	33%	2	14%
3	CPE 233	3	16	28%	2.43	31%
4	CPE 329	3	12	39%	3.7	10%
5	CPE 439	4	8	27%	4.6	0%

Figure 2 shows the average Likert scale values for all of the questions pertaining to mastery of material for all five courses listed in Table 1. The trend line shows the average of all of the questions to give a single numerical comparison between different courses. The data shows that all classes felt the group assignment method used in their class did contribute to their mastery of the material. Although there is no statistical difference between the average mastery values per class, the highest level of mastery was found in Class 1 presumably because individual submission of work was required, and the lowest level of mastery was found in Class 2. We have no way to tell whether the low scores for class two are an artifact of the small number of respondents for that course, or an issue with the group-work method implemented.

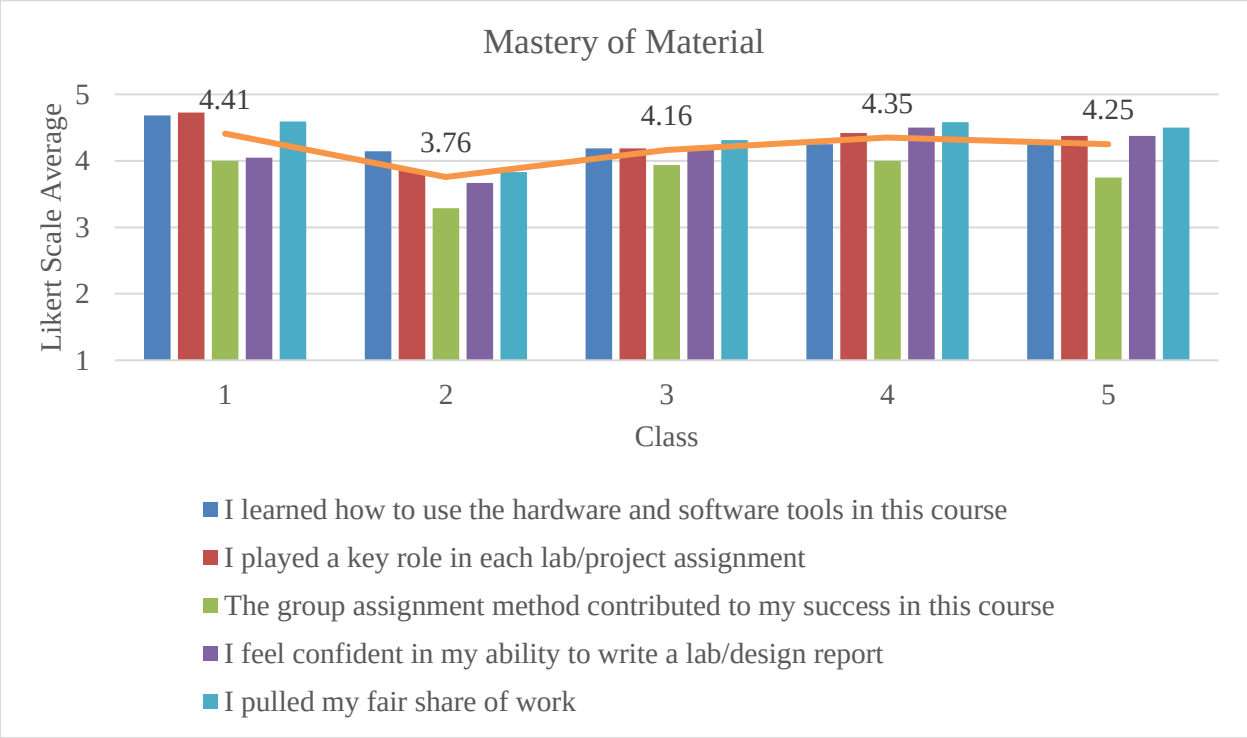

Figure 2. Average Student Responses for Mastery of Material

Figure 3 shows the average Likert scale values for all of the questions pertaining to comradery for all five courses listed in Table 1. The trend line shows the average of all of the questions to give a single numerical comparison between different courses. Note, that to compute the trend line averages, all averages for questions where a disagreeing response was positive for comradery (indicated with an asterisks) were subtracted from 6 to simulate swapping the Likert scale for that response. The data show that the highest comradery was found in classes 4 and 5 (the 300 and 400 level courses) presumably because more students know one another in upper division courses. Once again, the lowest comradery was found in class 2. Unfortunately, due to the low number of respondents from this class, it is impossible for us to tease out whether this is an issue of who chose to respond (selection bias), or if the group work method used for class two produced worse results.

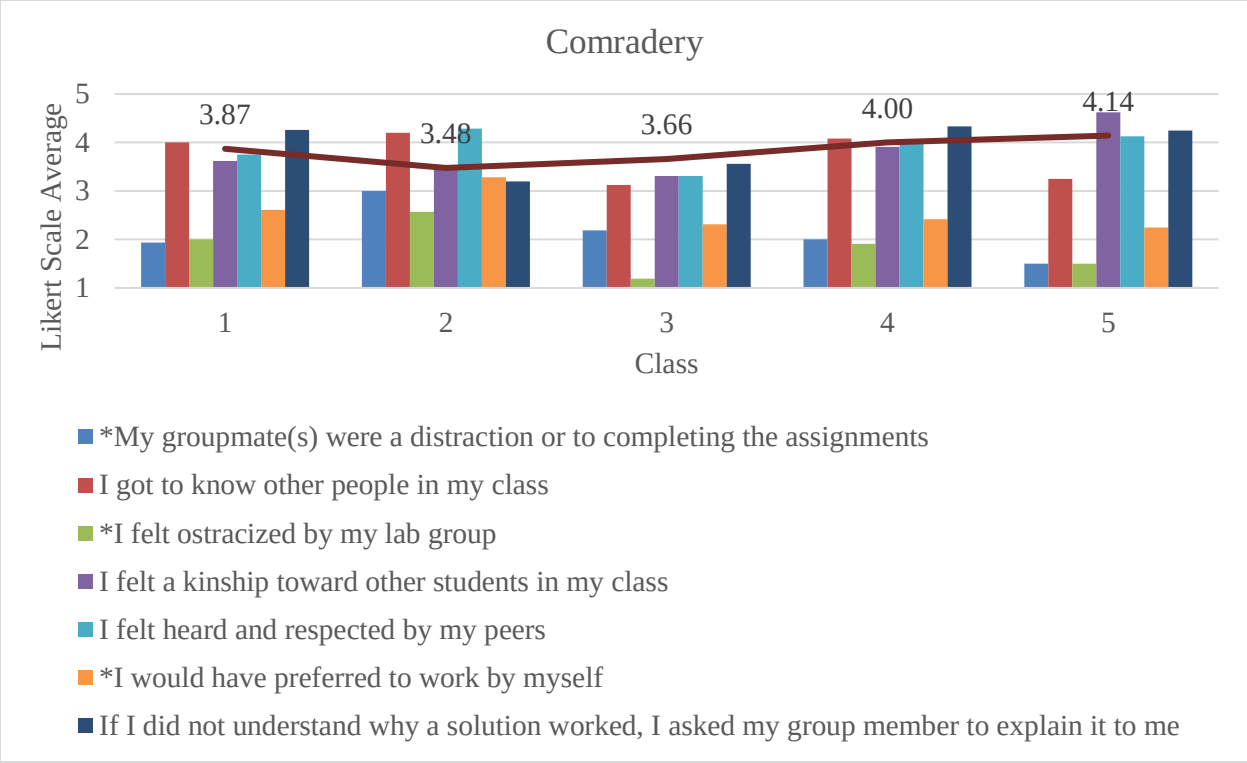

Figure 3. Average Student Responses for Comradery

Table 3 shows the percent of respondents who stated they would have preferred a different group assignment method. The data show that the majority of students in all classes were satisfied with the group assignment method used in their class. The higher percentages in preference for a different assignment method in Classes 2 and 3 largely stemmed from students indicating they had conflicts within their groups. Students in Class 2 who wished to change assignment methods said they would have preferred working in student selected groups, and frequently reported dissatisfaction with the quality of work produced by their instructor assigned partners. Students in Class 3 who wished to change assignment methods said they would have preferred working in instructor assigned groups because their particular student selected group was formed solely based on whom they happened to be sitting next to on the first day of class.

Table 3. Student Preference for Different Group Assignment Methods

Class Identifier	**1**	**2**	**3**	**4**	**5**
Prefer different assignment method	13.64%	42.86%	43.75%	25%	0%

Figure 4 groups a few of the open-ended comments into categories that describe the benefits (and some drawbacks) of Instructor Assigned Rotations, Student-Selected Single Group, Group Submissions, and Individual Submissions. Benefits of some group assignment methods can be seen as drawbacks of others.

Benefits for Instructor Assigned Rotations

"It was nice and made me work outside my comfort zone. I grew as a student and as an engineer."
"So far the group assignment method has been working out really well, it helps exposing us to how a real world job would work because we will never work with the same group for the rest of our career."
"I think it's better for the instructor to assign groups. Otherwise, you just end up being with the guy that sat down next to you on the first day of class, which I think is an awkward arrangement."
"I got to meet almost everyone in the class and be comfortable asking questions to anyone if I needed help."
"I had different groups each week. Some groups worked because all of the members of the group wanted to actually work together on the project / lab. Other groups didn't work when some people just didn't care about the lab and left you to do everything on your own."
"I got to meet new people each week and reduce the risk of having a bad group partner for the whole course"
"Getting a new perspective from others each week was beneficial."

Benefits for Student Selected Single Group

"I personally prefer to choose my own partner."
"It is better to stay with the same person and gain each other's trust and learn how to work with each other"
"It was easier for groups to collaborate since we had lab partners that we were for the most part familiar with."
"It is nice to work with friends"
"I was able to choose to work with someone I've partnered with in the past and I know I work well with."
"I enjoy having the freedom to pick."
"Group cohesion right off the bat, diverse skillsets"

Benefits for Group Submissions

"The stress of any assignment is much lower because you can work together and ask each other for help."
"lighter workload overall, but no compromise in learning."
"Ability to collaborate, split the workload, made assignments more enjoyable, able to hold each other accountable"

Benefits for Individual Submissions

"I got to meet a lot of new people and we weren't forced to work with anyone. We could ask each other questions and learn all the material."
"Because our projects were still individually completed, "partners" were more of resources to ask questions rather than a crutch on which to rely to complete the project."
"On average there wasn't a lot of cooperation, since everyone was individually responsible to complete the lab."
"No thinking about who is in my group. The lab was the focus."

Figure 4. Student Comments on Benefits of Group Assignment Methods

Finally, Figure 5 shows the results of the question, "In general, which do you prefer?". The data shows that over ⅔ of students in all classes prefer working in groups over working individually possibly indicating that no matter what group assignment method is chosen, there will always be students who just prefer to work alone. When working in groups, the majority in all classes stated they generally preferred the grouping method used in the course (instructor assigned rotating groups for classes 1&2, and student selected fixed groups for classes 3-5), except in class 2, where the majority preferred keeping the same group to rotating.

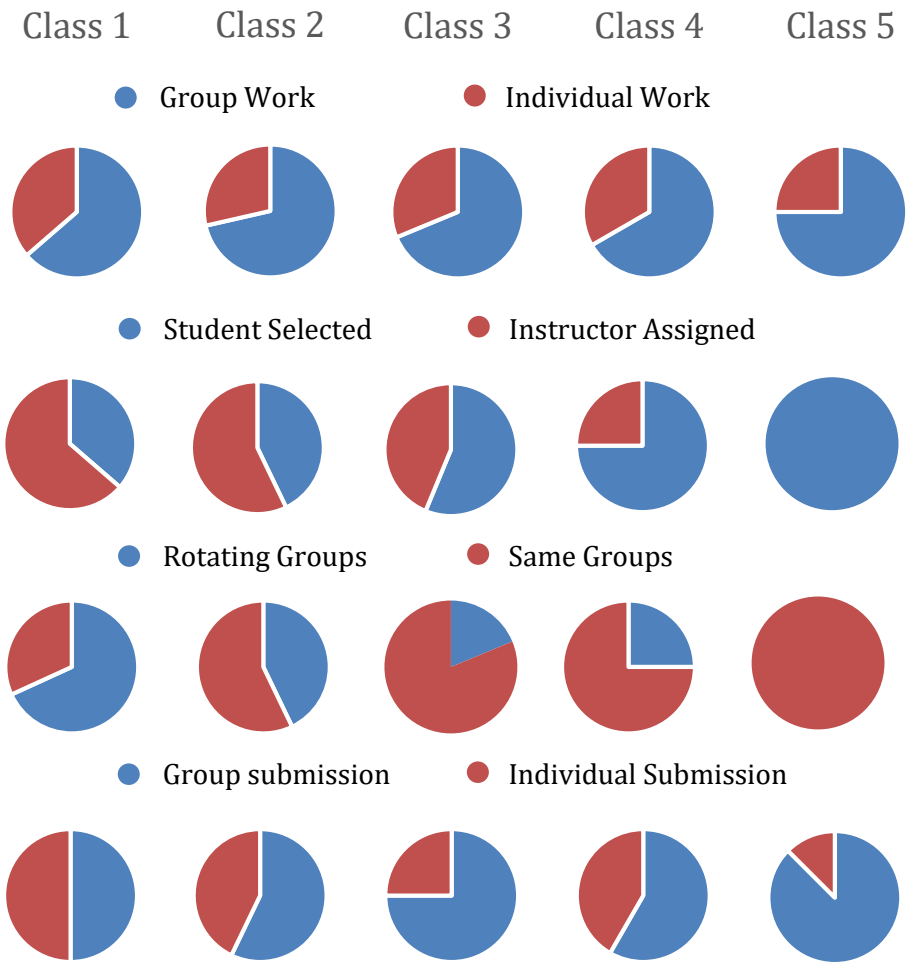

Figure 5. Student Preferences for Group Assignment Methods

Discussion

Mastery, Comradery, and Satisfaction data suggest that the group assignment method used in each course was appropriate. In the 100 level course, students may need the accountability of individual assignments to learn the material, even though 50% or more of the students indicated they prefer turning in gr0oup submissions. In 400 level courses, however, where students are enrolled primarily out of an interest in the subject matter, the use of group submissions can allow

students to tackle more advanced projects and gain a deeper level of understanding for the material. Providing students in 100 level courses structure for evaluating their partners' performance related to their group lab submissions, may also improve student accountability and mastery of the material.

From the comradery perspective, the preference for rotating and assigned groups at lower-levels and fixed groups in higher-division courses also makes sense. For younger students, a large part of the value added by group work is gaining familiarity and comfort with their academic cohort: "I got to meet almost everyone in the class and be comfortable asking questions to anyone if I needed help." Because of this, being required to work with new individuals gives students the social cover they need to expand beyond their existing social circles. The use of rotations also gives students an easy out of a bad group situation if they still have not matured to the level of practicing conflict resolution at the group level. By the time students reach advanced courses, however, and their major cohort starts to splinter into different specialties (e.g. power electronics, signal processing, etc.), they often know their classmates fairly well and have a good idea of who they can effectively work with. Also, as one student pointed out: "It is better to stay with the same person and gain each other's trust and learn how to work with each other." As students mature and near graduation and industry or graduate school, an increasingly important part of group work is learning group management and conflict resolution skills. Student selected groups with no rotations allow students to explore these issues in a safe and familiar environment.

Unfortunately, limitations in how the study was conducted may limit the strength of our conclusions. As noted, each class was mostly offered by a different instructor; therefore, we cannot eliminate the possibility that the effectiveness of a given variety of group work is largely dependent on the instructor's ability and comfort level with each type of group selection. Also, it could be the case that most students generally take a favorable view of whatever type of group work is offered in the course, and the fact that students report satisfaction with the changing nature of group work with course-level could be largely derived from what types of groups are available to them at each level. Further research and more data (including metrics other than student perceptions) are needed to tease out the full effect of year/student maturity on group work effectiveness.

Despite these limitations, we believe there is enough evidence through the responses to the question about general group work preference and responses to free response questions to suggest that the nature of group work changes as students mature and advance through the program. While younger, first and second year students need more structure and accountability in their group environment, upper-division students thrive in environments where they are allowed to explore their individual roles and responsibilities for creating a successful engineering solution.

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