AC 2007-2851: IMPACT OF STUDENT SELECTION OF DESIGN PROJECTS ON TEAM PERFORMANCE

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Abstract

In the capstone design courses, the instructor can choose among different strategies of assigning students to project teams. One of these strategies allows the students select the project they would like to work on from a list. This sometimes proceeds in an ad-hoc manner. Currently, literature offers limited research that looks at the reasons why students select certain projects. Furthermore, the work examining the impact of this selection on team performance is also limited. The objective of this study is to examine the impact of the students' project selection on team performance. This is carried out by (1) investigating the rationalization students undertake during the selection process, and (2) analyzing data concerning the influence of the selection on team performance. Two instruments are presented in this paper that can be used to analyze the impact of student selection of design projects on the team performance. These instruments are also used to track the types of projects the students select, such as faculty projects, industry supported projects, student initiated projects, and projects for design competitions. A systematic methodology, based on the students' rankings of all the projects for assigning students to their preferred choice of projects, is also presented. Whereas the data presented shows that students generally read carefully the project description, the majority of students prefer the project clients to make short presentations. To analyze the impact of project choice on team performance, four categories, based on the student project choice, were proposed. Teams whose majority did not get their first choice of project, showed the largest drop between the mid-semester peer ratings compared to end-of-semester peer ratings. This study was performed at two universities.

1. Introduction

The teaching of creative engineering design has a reputation for being both complex and challenging [1], but also for being underestimated [2]. The vagueness and open-endedness of the design process and the high level of creativity involved presents challenges for both students and lecturer and require further research and improvement [3]. Globalization and fast changing technologies require that engineering design education prepare students to become flexible, innovative, and resourceful engineers [4]. A researcher [5], reacting to increasing concern in industry about traditional engineering education, argues that 'autonomy and support' are significant contributors to creative engineering. This translates into an emphasis on creativity in a wider sense than is currently practiced [6]. Such an approach involves: analyzing individual learning types; providing engineering design tools, such as hand sketches; and introducing evolutionary design. This also involves exploring the notion of team creativity [7].

Team creativity is an important aspect of pan-mentoring. Pan-mentoring is a pedagogical approach to creative engineering design education that strives to establish a close relationship

with and within design teams of students [8, 9]. The functions of a pan-mentor are: the provision of additional information; the creation of a design conducive environment; the encouragement of autonomy and individual learning styles; and psychological support of the students [8]. This is all conducted in an environment that encourages students to be reflective while executing their projects [10]. The scheme of pan-mentoring including the assessment nodes is shown in Figure 1. Pan-mentoring was adapted in this research study.

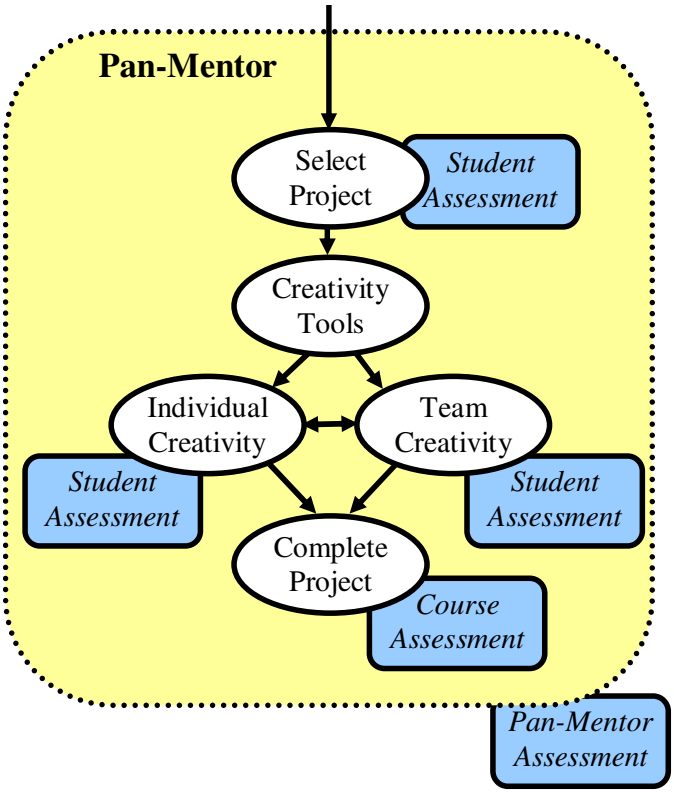

Figure 1 Pan-mentoring in creative engineering design[15].

There are four types of engineering design projects considered in the study, namely, faculty projects, industry supported projects, student initiated projects, and design competitions. If well structured, these projects provide the students with real-world challenges [11]. In design competitions, often the student teams represent their home institutions, and this has been shown to provide the students with an added incentive to perform well [12]. It has been recognized that generally, it is prudent to have a good balance of the four types of projects. The learning outcomes are affected by the kind of project undertaken by a design team [13]. Ford and Lasher [11] proposed an excellent scheme for screening projects to offer students.

In capstone design courses, there are different strategies of assigning students to project teams. One strategy is to let the students select the project they would like to work on from a list. This sometimes proceeds in an ad-hoc manner. Currently, in literature there is limited research looking at the reasons why students select certain projects. Also the amount of research looking at the impact of this selection on the resulting team performance is limited. Thus, there is a need

to understand the process the students go through in selecting a project from a project list. And then further more it is also important to also understand how a choice of project impacts the team performance. It is clear that there are many factors that affect team performance. The authors have in previous papers[8,9] considered other factors like Pan mentoring in team performance. Thus, the objective of this study is to examine the impact of the students' project selection on team performance. This is carried out by (1) investigating the rationalization students undertake during the selection process, and (2) analyzing data concerning the influence of the selection on team performance. Two types of survey instruments are used. The survey sample will be extracted from a freshman design engineering course and a capstone engineering design course. Two universities participated in this study.

2. Methodology

This study involved both freshman students and senior students at two different universities. The freshman students were part of an Introduction to Engineering design course, while the senior students were part of the first class of a two semester sequence class. The seniors had not previously been exposed to engineering design at freshman level at their university. The capstone students selected their own projects, while the freshman students were assigned to teams working on two types of projects. A total of 66 capstone students and 65 freshman students were involved in this study.

For the capstone design, 28 projects were solicited from industry, faculty, and students. Additionally, projects in design competitions were also entered in a project list. A project list was created and posted on the course website. The students were given a week to read the description and visit with the faculty advisor of each project. Where applicable they were also encouraged to meet with the clients. At the end of the week, the students were requested to rank *all* the 28 projects. This was done to encourage the students to read all the descriptions for all the projects. Using the students' choices, they were assigned to project groups in the second week of the semester. Towards the middle of the semester, the students completed a questionnaire to assess the project assignment. This was done using the survey instrument shown in Figure 2 that consisted of 32 statements. Students were trained on how to fill out the questionnaire, and implication of the ratings for example if a team member attended meetings 80% of the time they would get 4 out 5 rating.

Twice in the semester, the capstone students were asked to complete the peer review assessment instrument shown in Figure 3. The instrument had eight statements relating to the essential elements of teaming, such as leadership and communication. The results of this instrument was also used in calculation of the final grades for each student. For in depth analysis of the results obtained from this instrument, the students groups were divided into four categories based on the choices of each team member. Category 1 consisted of 6 teams where all the members received their first choice. Category 2 consisted of 6 teams where all the members received their first choice apart from just one member with a second choice. Category 3 consisted of 2 teams where all the members received their first choice apart from two members with a second choice. Category 4 was made up of 3 teams where just one member had a first choice, while the rest had their second choice. This last category included one team member who had a third choice. These resulting plots were analyzed.

PROJECT SELECTION QUESTIONNAIRE

Course No.:		Title:	
Instructor:		Expected Grade:	
Semester / Year:		Classification:	
Gender:		Age:	

The purpose of this questionnaire is to assess the project selection process. This information will be forwarded to the appropriated assessment committee and the instructor. Thank you for assisting in our efforts to improve the curriculum and meet accreditation requirements

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Statement	Statement Number
5	4	3	2	1	I selected the project after reading the project description	1.
5	4	3	2	1	I selected the project after visiting with the faculty advisor of the project	2.
5	4	3	2	1	I selected the project based on a class I had taken with the faculty advisor	3.
5	4	3	2	1	I selected the project based on a general impression of the faculty advisor	4.
5	4	3	2	1	I selected the project based on faculty advisor's in class presentation on the same	5.
5	4	3	2	1	I selected the project based on my interest in the field	6.
5	4	3	2	1	I selected the project based on my prior experience with a similar project	7.
5	4	3	2	1	I selected the project based on my colleague's encouragement	8.
5	4	3	2	1	The project description was detailed enough	9.
5	4	3	2	1	I read through all the project descriptions	10.
5	4	3	2	1	I visited with no faculty advisor	11.
5	4	3	2	1	I visited with 1-2 faculty advisors	12.
5	4	3	2	1	I visited with more than 2 faculty advisors	13.
5	4	3	2	1	I received the first choice of my project selection	14.
5	4	3	2	1	I received the second choice of my project selection	15.
5	4	3	2	1	I received the project that I proposed	16.
5	4	3	2	1	I received the project that my colleague proposed	17.
5	4	3	2	1	I was familiar with the project I selected	18.
5	4	3	2	1	There were 1-4 projects I did not care for	19.
5	4	3	2	1	There were 4-8 projects I did not care for	20.
5	4	3	2	1	I shared my first choice with my team mates	21.
5	4	3	2	1	I shared some of choices with my team mates	22.
5	4	3	2	1	I would have like to work only on my first choice	23.
5	4	3	2	1	I would have equally liked to work on my top two choices	24.
5	4	3	2	1	I would have equally liked to work on my top three choices	25.
5	4	3	2	1	I proposed my own project before I reviewed the list of the projects	26.
5	4	3	2	1	I proposed my own project after I reviewed the list of the projects	27.
5	4	3	2	1	I would have liked to have more detailed project descriptions	28.
5	4	3	2	1	I would have liked to have more faculty advisors make presentations on their projects	29.
5	4	3	2	1	I would have liked to have a more diverse offerings in the projects	30.
5	4	3	2	1	So far I am happy with our team work	31.
5	4	3	2	1	So far I am happy with my all my team members	32.

Figure 2 Project Selection Questionaire[15]

For freshman engineering the projects are part of an Introduction to Engineering course ENGR196. The course has two main components, ProEngineer drawing software and introduction to electrical circuits. In addition to these two components the students also participate in hands-on projects in teams of 2-5 students. There is no student selection process for the course; the projects are assigned by the instructor. Freshman projects were administered to two sections of the Introduction to Engineering course. The first section had 33 students assigned to teams of three to five students. Each team worked on the reverse engineering of a weed trimmer project [14]. There was a total of eight teams. The second section of the course had 32 students who were assigned Boe-bot Robot projects. It involved the assembly of the robots and programming them to perform specific tasks. This section was divided into teams of two to four students. There was a total of 12 teams working on robots. At the end of the projects, students filled out the team peer assessment questionnaire in Figure 3, which was also used as part of their project grade. The results of the assessment are discussed in the next section.

3. Results and Discussions

The results of the questionnaire were compiled and plotted. A similar questionnaire had been passed out in the preceding semester (Spring 2006). The results are shown in Figure 4. These results are compared with those received in the current semester (Fall 2006) (see Figure 5). Apart from three reversals (Statements 2, 11, and 20), the trends were consistent. The reversals included: a larger number of students did not consult with a faculty member making their selection (Statement 2 and Statement 11), and there was an increase in the number of students who found 4-8 projects not to their liking (Statement 20).

Based on Figure 5 the following trends can be observed:

1. A large number of students read through all the project descriptions (Statement 1 and Statement 10).
2. They selected the projects based on their fields of interest (Statement 6).
3. A large number of students preferred that faculty members (or project clients) make a short presentation on their suggested projects (Statement 29).
4. A number of students proposed their own projects (Statement 26 and Statement 27).
5. The students were happy with team work and team members (Statement 30 and Statement 32).

Two assessments were taken, one at mid semester (see Figure 6) and the other at the end of the semester (see Figure 7). Three of the four graphs show a general drop in rating between the mid of semester to end of semester. This could be attributed to the fact that by the end of the semester, the teams have had a chance to properly gauge the performance of each team member, there by indicating a more accurate evaluation. While at mid semester enthusiasm and optimism were still a factor in awarding the rating.

The most dramatic change occurs in Category 4 (Figure 6(d) and Figure 7(d)), where the majority of team members did not get their first choice of project. The biggest drops were registered in questions dealing with keeping team focus and priority (Statement 6 in team peer assessment questionnaire in Figure 3), together with lack of leadership (Statement 8 in team peer assessment questionnaire in Figure 3). There was also a large drop in show of initiative for

research and analysis (Statement 1 in team peer assessment questionnaire in Figure 3) with given tasks. Graph in Category 2 (Figure 6(b) and Figure 7(b)) had a trend opposite to the other three graphs. Its end-of-semester ratings were higher that those from mid-semester. This may require additional examination by comparing this data with the data from previous semester projects. The clustering of data between the ranges of 4 to 5 could be explained as follows, 1.) students were aware of expectations regarding each team member, team participation had been explained at the beginning of the project. 2.) Size of the teams did not provide room for students to get a free ride on other students' efforts. 3.) Pan Mentoring was used during the projects. 4.) Peer pressure from team members encouraged each person to perform.

It should be noted that the capstone design project lasted the entire semester, while the Freshman Engineering projects lasted three to four weeks of the semester. With the exception of Category 4 ratings, the ratings from the capstone design projects were generally higher than those in freshman engineering at the end of the semester. Senior design teams have more training in the design process than freshman teams; therefore they are expected to have higher ratings.

4. Conclusion

A large number of students read through all the project description. Furthermore, the students preferred that faculty members make short presentations on their suggested projects. Based on the assignment using the project choices, the students were generally happy with team work and team members. The category consisting of teams, whose majority did not get their first choice of project, showed the largest drop between the rating of mid-semester compared to end of semester. The biggest drops were registered in questions dealing with the upkeeping of team focus and priority, together with lack of leadership. There was also a large drop in show of initiative for research and analysis for given tasks. This seems to support the idea that the choice of project may impact the overall team performance and that additional study in this area is necessary.

5. Bibliography

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Figures

TEAM PEER ASSESSMENT QUESTIONNAIRE

(Please complete a separate questionnaire for EACH team member)

Your information:			
Course No.:		Title:	
Instructor:		Expected Grade:	
Semester / Year:		Classification:	
Gender:		Age:	
Team member's information:			
Name of Team member (not your name):			

The purpose of this questionnaire is to assess the team members in your design project.

Almost Always	Often	Some-times	Seldom	Almost Never	Statement	Statement Number
5	4	3	2	1	Showed initiative by doing research and analysis, took on tasks	1.
5	4	3	2	1	Prepared for and attended scheduled meetings	2.
5	4	3	2	1	Reliably fulfilled assignments and the work was of high quality	3.
5	4	3	2	1	Contributed to writing the final document of the semester (e.g., proposal, and final report)	4.
5	4	3	2	1	Contributed to preparing/making project presentation	5.
5	4	3	2	1	Kept team focused on priorities	6.
5	4	3	2	1	Listened carefully to contributions of others	7.
5	4	3	2	1	Demonstrated effective leadership on the team	8.

Additional comments

Figure 3 Team Peer Assessment Questionnaire[15]

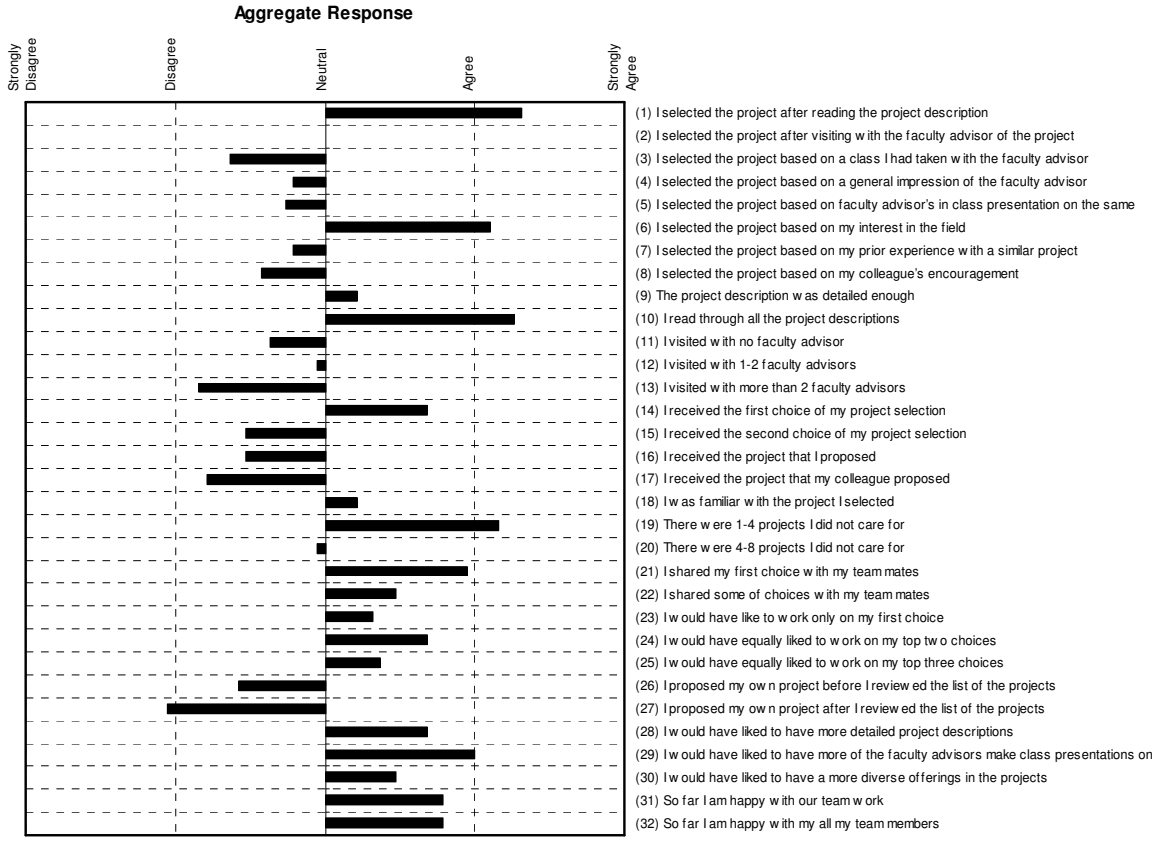


Figure 4 Project Selection in Capstone Design (preceding semester).

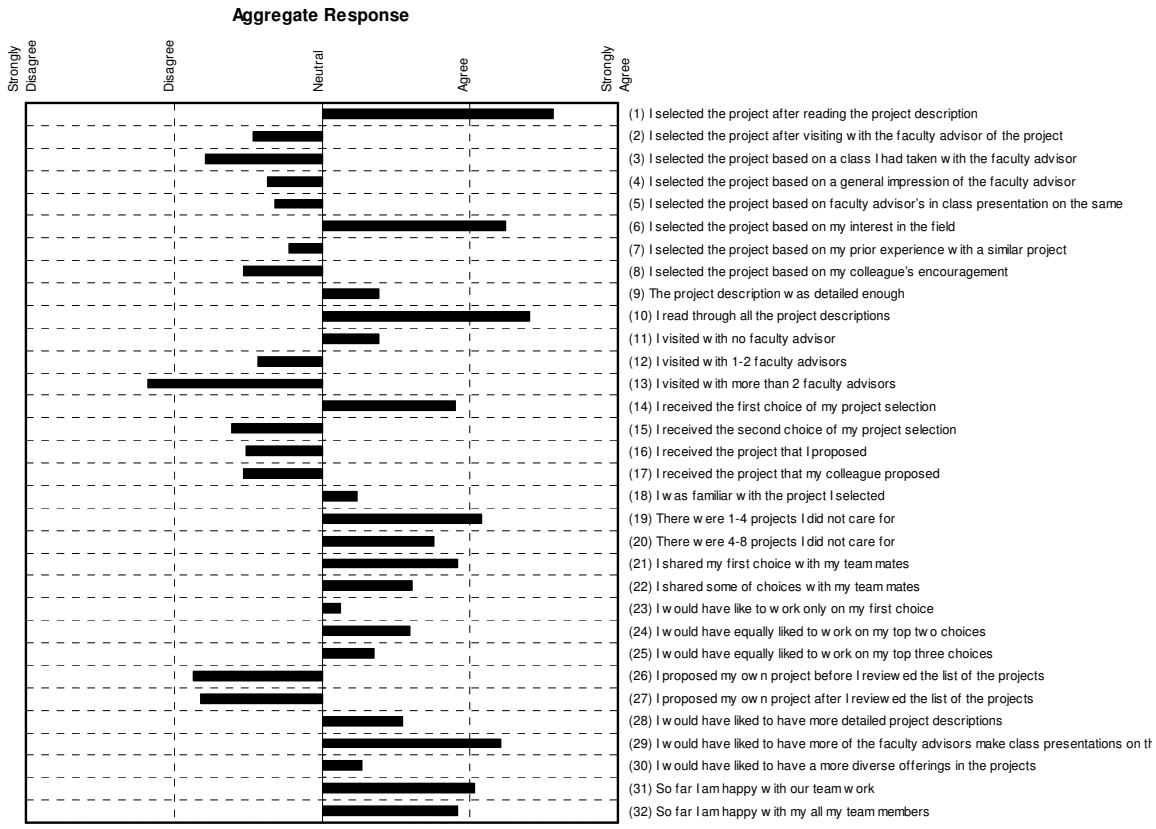
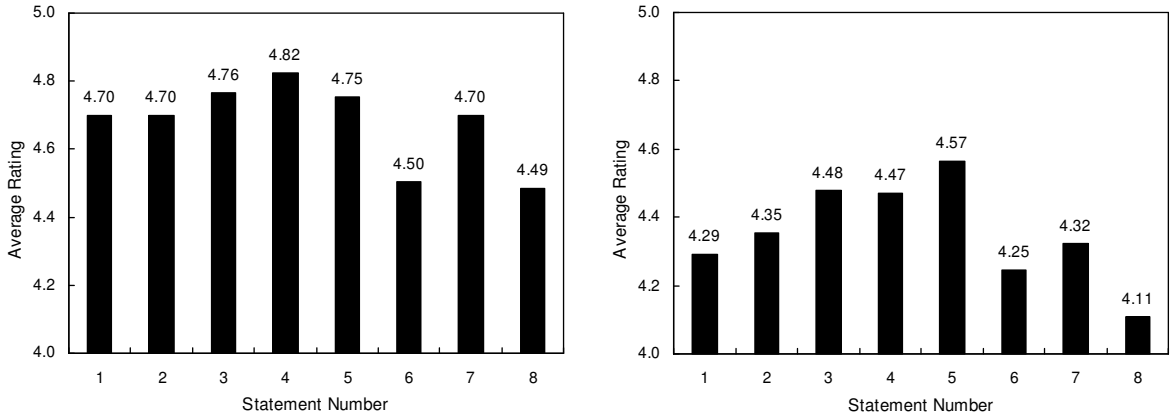
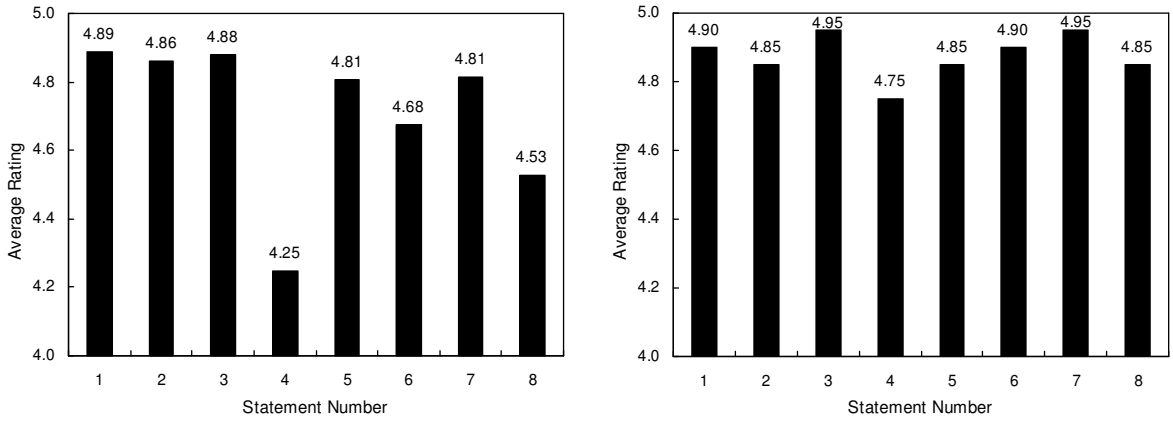


Figure 5 Project Selection in Capstone Design (current semester).





(c) (d)

Figure 6 Peer Assessment for Capstone Design at Mid of Semester (a) Category 1 (Only 1st), (b) Category 2 (All 1st except one 2nd), (c) Category 3 (All 1st except two 2nd), and (d) Category 4 (All 2nd or 3rd except one 1st).

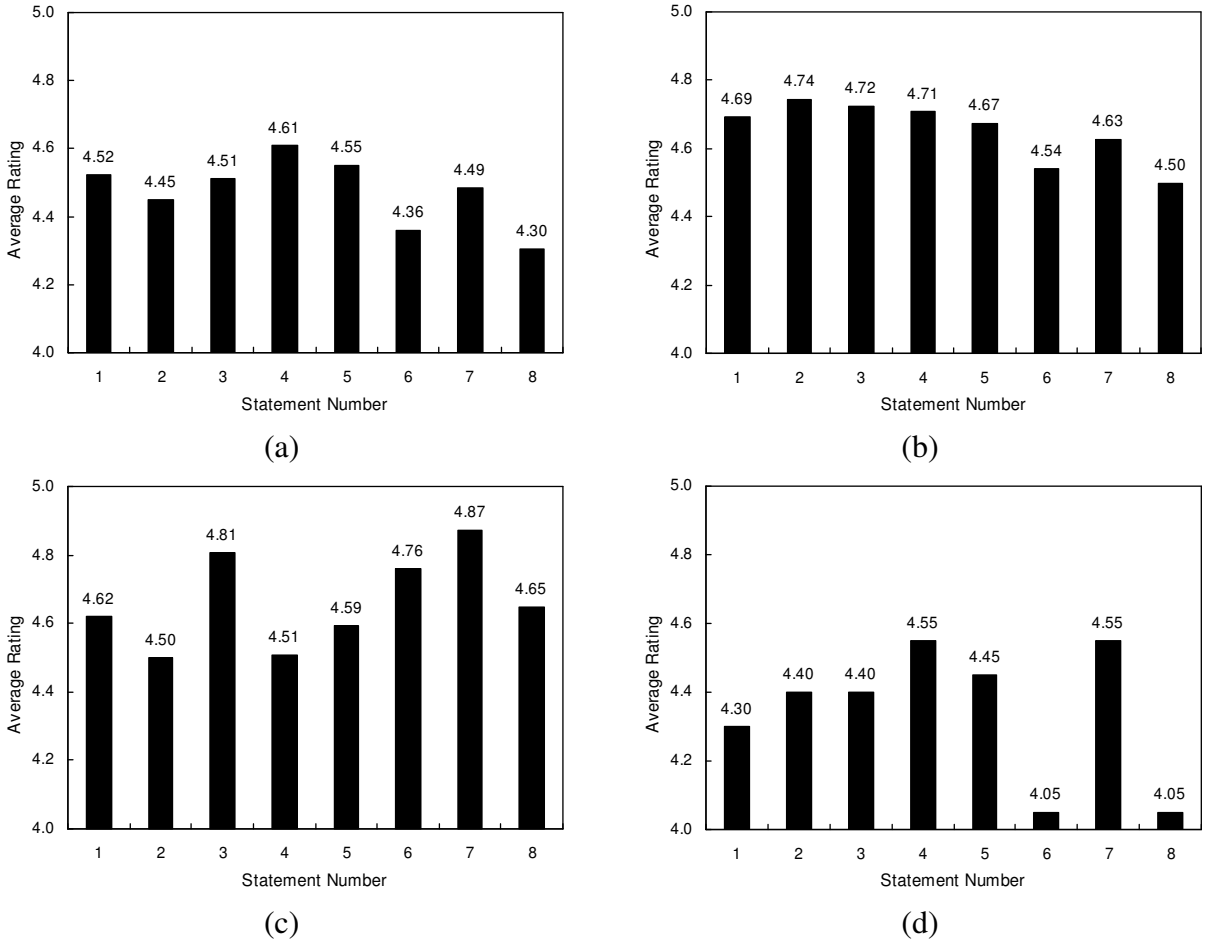


Figure 7 Peer Assessment for Capstone Design at End of Semester (a) Category 1 (Only 1st), (b) Category 2 (All 1st except one 2nd), (c) Category 3 (All 1st except two 2nd), and (d) Category 4 (All 2nd or 3rd except one 1st).

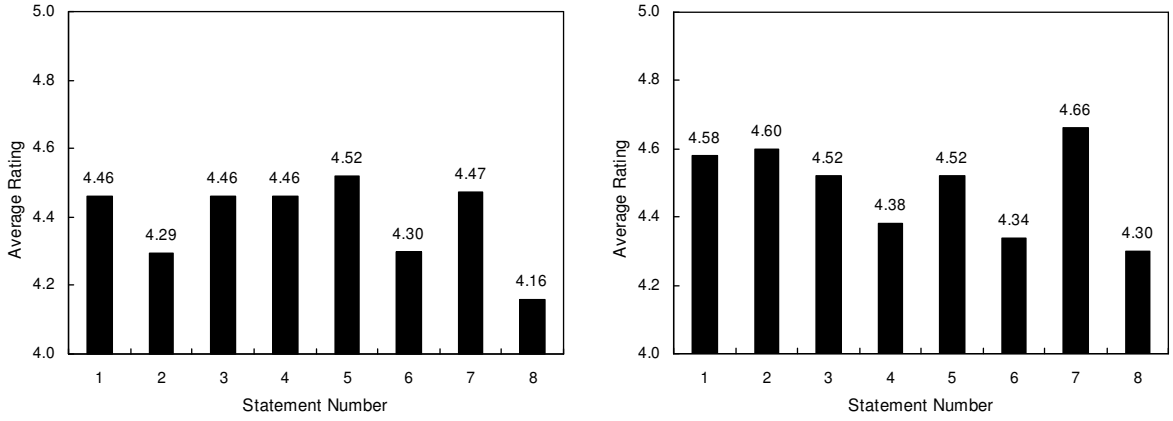


Figure 8 Peer Assessment for Freshman Design at End of Semester (a) Category 1 (Weed Trimmer), (b) Category 2 (Robot).