

# Self-Efficacy in First Year Design Courses Belonging, Satisfaction and Team Roles

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## Abstract

Project-based learning has become a widespread pedagogical method where students typically work in teams to complete a project. Engineering courses which utilize this method of teaching provide students with an opportunity to gain engineering skills and mastery experiences. This project investigates the self-efficacy of students before and after an engineering design course. Team roles, role models, satisfaction, belonging and gender roles were explored during the analysis.

## Introduction

Self-efficacy, an individual's judgment of their capability to organize and execute courses of action for a given task, is an important predictor of the retention of students in any major, including engineering [1]. In Bandura's model of self-efficacy, there are three major contributors: 1) social affirmation: personal validation, arising from the support and respect of others 2) role models: people who an individual admires and who embody qualities the individual aspires to obtain and 3) mastery experience: the successful or unsuccessful execution of a skill. [2]. If ways can be found to stimulate students with lower self-efficacy, the retention rate of these students will potentially increase ([1]. Bandura states that "the most effective way of developing a strong sense of efficacy is through mastery experiences [successful or unsuccessful performance of a task].

While education focuses on providing students with specific learning experiences, mastery of the skills needed to complete the task does not necessarily carry over to improved self-efficacy for the entire global concept of the overall task. One goal of project-based learning is to provide a feeling of success and accomplishment in a real world situation, through mastery of the specific tasks needed to complete the project. This logic becomes more complicated when the students

are placed in groups to complete these projects. Concerns arise when the students are not engaging in experiences that map to actual tasks and it becomes uncertain whether they have actually gained mastery experiences.

Recently arguments have been made that project based learning, especially in teams, will not necessarily increase a student's mastery skills and self-efficacy [3]. This hypothesis is supported by the idea that students working in teams can rely on the other students in the group while they may not personally gain the required skills, even though the project is completed [4]. Therefore, all students on the team may not necessarily engage in mastery experiences in a given area. This research project explores the effect of project-based learning in first year engineering design courses on self-efficacy.

## **Methods**

The data presented here was collected in 2011 and 2012 from a first-year design course at a small, private engineering college. A mixed methods approach was used.

The first-year engineering project-based design course requires the completion of two major projects and is graded as pass/no record. In the first half of the course, the students are guided through an individual design project. During this project, they primarily learn the engineering design process and a few important skills they will need, on both an engineering and professional level. During the second half of the course, the students work in teams of four or five to produce a biomimetic electromechanical toy. The second half also includes information and skills development around project management and teamwork.

Quantitative data about student experiences was collected through pre and post-course surveys that addressed individual self-efficacy, as well as demographics, previous engineering and related experience and role models. Students were asked to complete weekly activity logs during the course. These logs recorded the amount of time the students spent on different activities pertaining to the course, with the goal of investigating the relationship between self-efficacy and activities in the course.

On the qualitative side, semi-structured interviews were conducted with the students after the end of the course. In these interviews, students were asked about a number of factors which related to their self-efficacy development, including role models, reasons they were in engineering school, their satisfaction with the course, and their experiences as part of a team for the second project.

The interviews were transcribed and anonymized. The interviews were read carefully and coded. After several passes with the data, themes began to emerge and two subtopics were formed: 1) How Role Models Influence Team Roles and 2) How Satisfaction and Belonging Influence Team Roles. Additional themes also emerged during the analysis and they are represented in the table below. Each item in the table is then substantiated by qualitative quotes shown in the table which follows. The 'Apparent Themes' were specifically mentioned by the students during the course of the interviews. The 'Subtle Themes' were that emerged through interpretation and analysis.

Apparent Themes	Subtle Themes
Teamwork	College Curriculum
Roles and Division of Labor	Stereotype Threat/Stereotypes
Motivation and Role Models	Factors that Affect Self-Efficacy/Confidence
Satisfaction	Sense of Belonging

Apparent Themes	Student Responses from Interviews
Teamwork	The number of times “we” was used compared to the number of times “they” was used (e.g. 25 “we” versus 2 “they” indicates a high feeling of teamwork.)
Roles and Division of Labor	“I was generally the main scheduler. I was kind of in charge... I was far more interested in getting the other experiences more like project management or working with other people.”
Motivation and Role Models	“I decided to study engineering because both my parents are engineers...”
Satisfaction	“I wish I did more for the project then I ended up doing.”
Subtle Themes	Student Responses from Interviews
College Curriculum	“I feel like I learn [all that] a lot better when I have something where I will use it....[This college] is very good at that.”
Stereotype Threat/Stereotypes	“We had her sew everything.” “Like the things girls typically do.”
Self-Efficacy/Confidence	“I’m not really confident at all. And like, yes, I can engineer this thing, you know. I didn’t have that {positive} sense [about engineering the project]”
Sense of Belonging	“Everyone was involved. Everyone contributed”

## Discussion

We chose to focus on sense of belonging and team roles as they pertain to gender. Our preliminary findings suggest that, for an individual to feel personal satisfaction with the group and the product produced, they need to feel a sense of belonging and usefulness to the team. The

students' team roles also seem to play an important part in their sense of belonging and usefulness.

The different tasks the students chose to perform for the group were broken down into two broad categories: professional skills and technical skills. Professional tasks include leading, scheduling, planning and project management. Technical tasks include manufacturing, CAD and design. For the most part, the men seem satisfied completing either the professional tasks or the engineering tasks. As long as men felt the task they were completing was useful to the group, they felt a sense of belonging to the group and satisfaction on personal and professional levels. Women, on the other hand, had to be involved with the technical skills aspect of the project to feel a sense of belonging and satisfaction. This was observed in 12 out of the 14 interviews with women. These results are preliminary and future work needs to be done to validate it.

### Example quotes from interviews that show belonging to the team and team roles

#### Male student

##### **Belonging:**

"Everyone was involved. Everyone contributed"

##### **Tasks:**

"I was generally the main scheduler. I was kind of in charge... I was far more interested in getting the other experiences more like project management or working with other people."

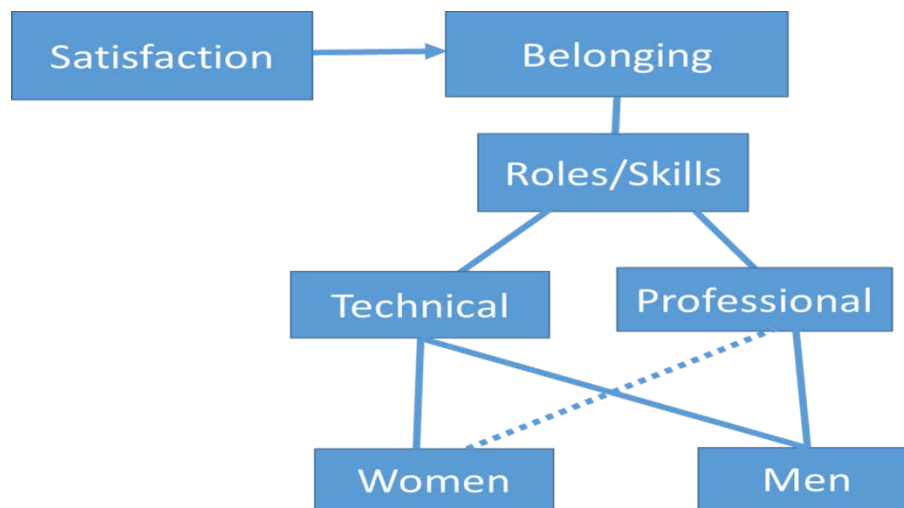
#### Female student

##### **Belonging:**

"I don't think there was really ever [a time] when I felt like I didn't belong"

##### **Tasks:**

"mainly CAD assembly, and machining, and actually assembling the [animal]"



## Future Steps

The next steps of this project would be to further investigate the relationship of gender to satisfaction and belonging.

This includes linking some of the qualitative findings with the quantitative data, such as relating demographics from the quantitative survey, like gender, race, etc. with the qualitative themes found, including team roles, satisfaction, stereotype threat, etc.

Finally, it would be important to see if there is a link between the sub-topics described here, 1) How Role Models Influence Team Roles and 2) How Satisfaction and Belonging Influence Team Roles to the main theme of the study, self-efficacy, in order to understand their relationship to the development of self-efficacy, if one exists.

## Conclusion

From qualitative analysis of interviews with first-year engineering students, a connection was found between a sense of belonging and personal and group satisfaction. Without a sense of belonging to the group, both men and women are not satisfied with the amount they accomplished. Furthermore, women, for the most part, needed to be involved with the technical tasks to have a sense of belonging to the group. On the other hand, men who worked on either technical tasks or professional tasks felt a sense of belonging and satisfaction. These results are preliminary and additional work in this space is in progress.

## **Bibliography**

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