Investigating task choice in first-year engineering team projects

Alexa Steiner[1], Laura Hirshfield[1], Cynthia Finelli[1], and Debbie Chachra[2]

1. University of Michigan Center for Research on Learning and Teaching in Engineering
2. Olin College of Engineering

Motivation

Confidence is defined as an individual's self-assurance coming from appreciating one's abilities.

Self-Efficacy is defined as an individual's belief about their capabilities to perform a task.

Projects = Mastery Experiences → Self-Efficacy

Hands-on project design-based courses are created to give students real-life engineering experience. These classes could increase a student's Academic Self-Confidence and Self-Efficacy about engineering tasks.

The change in Academic Self-Confidence or Self-Efficacy can be affected by:

- Amount of time spent on engineering related tasks
- The role that the student played on their team

Research Questions

1. How are students spending their time in design courses?
2. Do male and female students spend their time in different ways?
3. Does the amount of time spent on tasks correlate with a student's change in Academic Self-Confidence or Self-Efficacy?
4. What roles are students playing in their teams?

Methods

- Mixed-methods concurrent triangulation approach
- **Participants**
  - 111 students from the University of Michigan
  - Course Descriptions

ENGIN100-150	ENGIN100-400	ENGIN100-600	ME 250	CHE 489	EECS 467
First year course where teams design, build and test a human-powered electric generator. Students will apply principles of force, power transmission, electric and magnetic circuits and electrical energy generation.	First year course where students design, build, and test a wirelessly networked product that is self-powered by solar cells by learning about electrical circuits, solar cells, energy storage, micro-controllers, and wireless technology.	First year course where students design, build and test an underwater Remotely Operated Vehicle. Topics include 3D modeling, system design, technical documentation, and team communication.	Sophomore level course where students are introduced to basic mechanical design and manufacturing. Students will be exposed to CAD systems and machine shop techniques.	Senior level class where teams produce a consumer ready prototype of a chemical produce. Students prepared oral, written and economic reports about their product.	Senior level class designed to give students a hands-on introduction to robotics from a computer science perspective. Emphasis on laboratory design and programming of a robotic system.

- **Data collection**
  1. Pre- and post-course surveys to assess demographics, personality, confidence & self-efficacy

Commitment to Completing Degree	
Confidence in Completing Degree	
Academic Self-Confidence	Problem-Solving Math & Science Skills Professional & Interpersonal Skills
Self-Efficacy	Engineering Tinkering

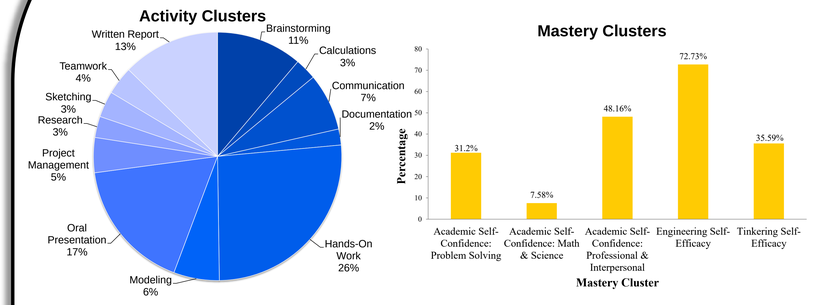
  2. Weekly activity logs, including tasks later organized in 2 sets of clusters:

Mastery Clusters	Activity Clusters	
Problem-Solving Math & Science Professional & Interpersonal Engineering Tinkering	Brainstorming Calculations Communication Documentation Hands-on Work Modeling/CAD	Oral Presentation Project Management Research Sketching (2D/3D) Teamwork Written Report

     - The average amount of time per week students spend on each cluster was calculated. This number was used in all the statistical analysis.
  3. Semi-structured interviews
  4. Team observations

Results

How Students Spend Their Time



CHE 489 students spent the largest percentage of their time on Oral Presentations and Engin100-150 students spend the largest percentage of their time on Written Reports. It was surprising that the students spent the most time on communication-related tasks instead of hands-on work in a design course.

Top five tasks that students spent their time on in each class.

ENGIN100-150	ENGIN100-600	ME 250	CHE 489	EECS 467
Written Reports	Hands-On Work	Hands-On Work	Oral Presentations	Hands-On Work
Oral Presentations	Oral Presentations	Oral Presentations	Hands-On Work	Communication
Hands-On Work	Written Reports	Brainstorming	Written Reports	Oral Presentations
Brainstorming	Brainstorming	Modeling	Brainstorming	Brainstorming
Communication	Communication	Communication	Research	Written Reports

Differences Between Genders

Course	Significant Difference P-Value	
	P < 0.05	P < 0.1
ENGIN100-150	-	-
ENGIN100-600	-	Written Reports
ME 250	-	-
CHE 489	Communication ASC: Professional & Interpersonal	Calculations Hands-On Work Teamwork Written Report ASC: Problem Solving
EECS 467	Only one woman participated so t-tests could not be conducted for this course.	

Indicates that women spent more time on average per week on the tasks in this cluster.
Indicates that men spent more time on average each week on the tasks in this cluster.

The only class with a statistical difference between the way that men and women spent their time was in CHE 489, a design course for seniors in chemical engineering.

Correlations between Tasks and Confidence & Self-Efficacy

Measure Change		Percentage of Time on Task	Average Time on Task
		Positively Correlated	Positively Correlated
Commitment to Completing Degree		-	Calculations
Confidence in Completing Degree		-	-
Academic Self-Confidence	Open-Ended Problem Solving	Oral Presentation Project Management	Oral Presentation
	Math and Science	Communication Documentation Hands-On Work Modeling Project Management Research Sketching ASC: Problem Solving ASC: Math & Science ASC: Professional & Interpersonal Engineering SE Tinkering SE	Communication Documentation Hands-On Work Teamwork Written Report ASC: Problem Solving ASC: Math & Science ASC: Professional & Interpersonal
	Professional and Interpersonal Skills	-	Research ASC: Problem Solving
Self-Efficacy	Engineering	-	Oral Presentation ASC: Math & Science
	Tinkering	Documentation	Modeling

A correlation was used to see if the amount of time spent on any of the Mastery or Activity Clusters correlated with the amount of change students had from their entrance to exit scores in their Academic Self-Confidence and Self-Efficacy.

Significant with $p < 0.05$
Indicates a positive correlation
Indicates a negative correlation

An increase in Academic Self-Confidence: Math & Science was correlated with the amount of time spend on many different Mastery and Activity Clusters.

Ethnographic Observations

In phase two of the study, we implemented an ethnographic study to follow two groups of students through their project experiences. An observer was present any time that the group met with at least three team members present. The observer attended any lab time where the group met to complete their project in the first-year project laboratory. They also went to extra lab hours and lab office hours with the teams and were present when they had team meetings about writing their final report and presentation. At this time, we have observed two first-year teams through one project course and are in the process is observing more.

In both of the teams, there was a very clear adoption of roles by students. For part of the project, the students were required to write code to control their devices. In both groups, one person did all of the coding while other students worked on designing and building their device. **There was also a distinct leader in each group that the other students looked to for advice and approval.**

When observing teams during phase two of the study, gender roles within teams seemed to be even more pronounced as well as how lack of confidence affects male and women students differently. This was in line with the results found in the quantitative analysis done for the first phase. **The less functional team that was observed was comprised of unconfident students; but only the female student missed out on mastery experiences and skill development because of her lack of confidence**.

Future Work

1. Would assigning students specific roles, based on individual learning goals, improve self-efficacy? Could teams consist of students with a variety of learning goals and be given tasks that were directly related to what they wanted to get out of the class?
2. Is there a way to make the project tasks more uniform in terms of workload and skill development for each student?
3. What traits, beyond the individuals that compose it, makes a team more confident than other teams? How much does team dynamic play into the confidence of a team or the confidence of each individual student on the team?

CRLT-ENGIN
UNIVERSITY OF MICHIGAN

Contact:
alexans@umich.edu

This research was supported by a TLTC grant and the National Science Foundation under EEC-0953698. 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.