Relating project tasks in design courses to the development of engineering self-efficacy

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Introduction

Engineering self-efficacy, the strength of one's belief that one is able to complete an engineering task, is necessary for students to persist in the field and continue to be motivated to learn and challenge themselves.[1] Students who have a high level of academic self-confidence feel a sense of self-assurance about themselves, whereas students with high self-efficacy are sure that they can complete certain tasks when faced with the challenge. Also, while academic self-confidence is a more generalized belief in one's self, self-efficacy is domain- and context-specific.[2] Both academic self-confidence and self-efficacy are important for motivation, retention and successful progress through a degree program.[3,4] Self-efficacy can be increased through social affirmation, or encouragement from another person, or through "vicarious experiences" or modeling, in which someone may feel affirmed by seeing others succeed or may mimic the behavior of role models to succeed. Self-efficacy is also improved by engagement in "mastery experiences," practices that gives student more experience in the field in which they are studying. Mastery experiences have even been found to be the most influential contributor to self-efficacy.[5,6] By completing engineering mastery experiences, students are likely to believe more strongly that they are able to complete difficult engineering tasks, and this increased self-efficacy leads to increased persistence in engineering.[7] Projects, which require students to apply engineering fundamentals in an industry-relevant work environment, have the opportunity to provide students with relevant mastery experiences that can improve their academic self-confidence and self-efficacy.

Project-based learning has become an important part of higher education.[8] Projects not only improve learning outcomes, but also increase motivation by demonstrating how acquired knowledge and skills will be used in a practical setting.[9–12] They also improve students' non-technical skills, such as communication, teamwork, and project management, that are key to a successful career as a practicing engineer (and for most other career paths).[9] In project-based learning, students must consider both the process and the product, as they collaborate on creating the deliverables for the project.[13] Project work emphasizes learning by doing, and engineering projects that involve hands-on work and the generation of a physical prototype can be considered to be a "mastery experience" that can both improve student learning and also increase engineering self-efficacy.[14,15] However, the benefits of generating a physical prototype accrue to the students who were most involved in creating it; students who participated less in the technical aspects of projects may not observe the same improvements in engineering self-efficacy as their more-involved peers.

In this study, we are focusing on the relationship between the tasks that students take on in project work and student's beliefs and characteristics: specifically, academic self-confidence, engineering self-efficacy and gender. We are examining the relationship between the tasks that students take on during a project course and the students' incoming and outgoing confidence and self-efficacy levels, by exploring the following research questions.

1. Did students' academic confidence or engineering self-efficacy improve after the project course?
2. Were there differences between the academic confidence or self-efficacy of male and female students?
3. Was there a relationship between the tasks students engaged in and their incoming confidence and self-efficacy measures?
4. Did any tasks correlate to observable changes in confidence or self-efficacy measures?

Both academic self-confidence and self-efficacy have a strong effect on student motivation and decision-making. Academic self-confidence in three particular areas (problem-solving,[16] math and science,[17–19] and professional and interpersonal skills[7]) have been found to be important factors in student persistence and progress,[20] whereas self-efficacy beliefs influence decisions that people make.[21–25] Students with lower incoming engineering self-efficacy may be less apt to take on more technical tasks (or be less likely to be tasked with them by the group), and may default to tasks that don't require them to develop new technical engineering skills, such as scheduling team meetings or designing slides for the team's oral presentation.[26] As a result of spending less time on engineering work, these students may fall into a "pernicious cycle:" low initial engineering self-efficacy means that they do not engage in the types of tasks that would increase it, and failing to engage in these tasks means their engineering self-efficacy doesn't increase, potentially setting them up to repeat the pattern in subsequent courses. We are also investigating the students' outgoing confidence and self-efficacy levels with regards to the tasks that they complete as a part of the project, to determine if certain classes of tasks lead to higher increases in confidence or engineering self-efficacy.

Another important factor that may influence students' participation in mastery experiences is gender. Previous studies indicate that male students engage in more engineering activities and thus experience a greater increase in engineering self-efficacy.[27] Widely-held gender schemas suggest that men are better at engineering and "engineering tasks," which include goal-focused, technical tasks.[28,29] These schemas, held consciously or subconsciously, could mean that women may be less motivated to participate in engineering tasks, may not be trusted by other team members to do the engineering tasks, may be tasked with stereotypical "female" tasks (taking notes, managing the team, scheduling meetings, writing reports) or may choose to do those tasks in order to maintain social cohesion within the group ('being a good team player' who steps up to do needed tasks).[28,30,31] Gender differences in team projects may therefore have a critical effect on the types of mastery experiences that students engage in and thus on the development of their engineering self-efficacy.[26]

Research Methods

Participants and Settings

This pilot study focuses on two preliminary data sets: one set from students at a small, private engineering college and one pooled set from students at three different large, public universities.

The first set focuses on 52 first-year students enrolled in a multidisciplinary engineering program. Twenty-four students identified as male, 26 as female, and two students declined to provide their gender. The students were surveyed about their experience in a first-year engineering design project course. For the first half of the course, students worked on individual hands-on projects; in the second half, they worked in teams of five to design and fabricate a more complex prototype. Thirty-five students were enrolled in the course in the Fall 2012 semester and 17 students in the Fall 2013 semester; the data from the two years was pooled after t-tests revealed that there was no statistically significant difference between the data from each year for the relevant parameters. The structure of the course, and most of the instructors, were the same in both years.

The second dataset focuses on set of 25 students enrolled in three different large, public universities; again, these data were pooled after finding no statistically significant differences between data from each school. These students all participated in a first-year engineering course that involved a significant hands-on design project, although the structure of the course, project, and instructor involvement differed somewhat.

Data Collection and Analysis

This research study used a mixed-methods concurrent triangulation approach. Quantitative surveys gauging academic self-confidence and self-efficacy were used, consistent with other similar instruments.[3,32–37] Recognizing that academic self-confidence, self-efficacy and project experiences cannot be fully described using quantitative means, there was also an interview component to provide qualitative data, which also provides a more nuanced and holistic insight into student experiences.

Participating students were asked to complete an entrance survey at the beginning of the course, an exit survey at the end of the course, and weekly activity logs throughout the course to track the specific activities they were engaged in. The entrance survey including questions about demographics, prior engineering experience and exposure, and personality (using the Big 5 Personality Test[38]). Both the entrance survey and exit survey included instruments to assess the students':

1. Commitment to completing an engineering degree
2. Confidence in completing an engineering degree
3. Academic self-confidence in three constructs:[20,32,33]
    - Open-ended problem-solving
    - Math and science skills
    - Professional and interpersonal skills.
4. Engineering self-efficacy[39]
5. Tinkering self-efficacy, which relates to one's "experience, competence, and comfort with manual activities"[39]

The academic self-confidence instrument was included not only because self-confidence is important to a student's identity and will influence student's project experience and task choice, but also to enable comparison of the data to previously collected data within the Center of Advancement of Engineering Education.[20,33] The self-efficacy instruments, developed by Baker et. al,[39] were included to gauge student's beliefs in completing a multitude of engineering and hands-on tasks. Recognizing that self-efficacy is context-specific, we wanted to measure students' engineering self-efficacy to determine their comfort with and confidence in completing tasks specific to an engineering major or field, such as statistical analysis, modeling, design, math calculations, or communication. The tinkering self-efficacy instrument was utilized to focus more narrowly on the hands-on aspect of engineering project work, as the development of prototypes has been found to be particularly important in increasing self-efficacy beliefs in first-year engineering design.[27]

Survey questions for each item asked students to rate their agreement on a Likert scale, from 1-7 (the academic self-confidence items) or 1-5 (all other items). In this work, we present all results normalized to a scale from 0 to 1.

The weekly activity log surveys questioned students about how they had been spending their time over the past week with regards to the course overall and specific project tasks. The activity log included forty different tasks that the students could report the time they spent working on. The list of tasks was empirically-derived at the small private college, emerging from what students reported doing most in their first-year project course. The surveys also included open-ended response questions, allowing students to describe additional tasks that they completed, why they chose the activities that they did, and a general analysis of the project that week.

During analysis, the individual tasks were separated into two different types of clusters: mastery clusters and activity clusters. For the mastery clusters, individual activities were mapped onto each of the academic self-confidence and self-efficacy measures described above; that is, that they were considered to be 'mastery activities' that would contribute to self-efficacy in the specified area. Tasks were included in a mastery cluster if there were an item on that survey instrument that directly referred to that task. For example, "communicating with team members" would be included in the engineering self-efficacy cluster because it maps on the "I can communicate ideas and concepts to others." Some activities were mapped onto more than one self-efficacy/self-confidence measure; for example, written communication activities were associated with both academic self-confidence in professional and interpersonal skills and engineering self-efficacy.

The second cluster used when analyzing the activity logs was activity clusters. These clusters were more general, organizing the tasks into the following areas based on the primary nature of the task:

- Brainstorming
- Calculations
- Communication
- Documentation
- Hands-On Work
- Modeling/CAD
- Oral Presentation
- Project Management
- Research
- Sketching (2D & 3D)
- Teamwork
- Written Report

A subset of students participated in semi-structured interviews after the project concluded. The interviews were designed to gain more insight into the students' incoming and outgoing confidence and self-efficacy levels and the factors that often affect self-efficacy, including mastery experiences, social affirmation or role models. Students were asked a range of questions to probe experiences that may have affected their self-efficacy, about their experience in the project and with their teams, and their perception of the field of engineering in general.

The data analysis presented here focuses on the pre- and post-course survey results from the large, public universities, and all data (pre- and post-course surveys, activity logs, and interviews) from the small, private college. Statistical analysis of survey results were performing using SigmaPlot statistical software (v 13; Systat Software Inc.). Qualitative analysis of the interview transcripts was performed using NVivo coding software (QSR International).

Results and Discussion

The participants in this study were all enrolled in first-year engineering design courses that included a significant project component, in which students worked in teams to produce a physical prototype. Here, we present preliminary results from two differing sets of data. Studying these two contrasting datasets provides insights into two different types of project experiences; we are able to compare student experiences in a team project in a more typical engineering course structure to students working on a full-semester project course in a non-traditional program. Although the structure, deliverables and learning outcomes for each project are different, the context of each project experience is similar: a first-year engineering design course with a substantial project component that requires development of a physical prototype.

One set of data focuses on students in a small, private engineering college with an atypical, project-focused curriculum. This college has a highly selective multidisciplinary engineering program with an equal number of male and female students. The course targeted for this study consists almost exclusively of project work, and the students have not declared specific engineering disciplines at the time of taking the course. The student experiences in the course have been previously investigated, and the course design includes a number of learning interventions to specifically address student activities and behavior in the course.

The second set focuses on students in more “traditional” engineering programs. In this dataset, gender demographics are more representative of undergraduate student enrollment (women are in the minority), students are enrolled in a specific engineering major, and courses may contain a team-based project component without devoting the majority of course time to the project. Although we recognize that each university did provide a unique project experience to their students, data from the three universities is pooled due to a small number of students participating in each school individually and a lack of statistically significant difference between the datasets; this set of data offers a point of contrast to our second set of data and provides motivation for collecting more data from a wider variety of universities, which is currently ongoing.

In analyzing the two separate datasets, we consider the following research questions:

1. Did students’ academic confidence or engineering self-efficacy improve after the project course?
2. Were there differences between the academic confidence or self-efficacy of male and female students?

To address these research questions, paired t-tests were done on each confidence and self-efficacy measure to compare the students’ levels before and after the project course. T-tests were done to compare male and female students groups to determine if there was a significant difference between the levels of each gender group. These are preliminary approaches; additional statistical analysis of the data is ongoing.

Project Experiences at Small Private Schools

Change in Confidence and Self-Efficacy Measures throughout the Project Course

The students’ reported confidence and self-efficacy between the beginning and end of the project course were compared, as shown in Table 1. The project course seemingly had less influence on the confidence of these students; most measures stayed level while the only statistically significant difference was a *decrease* in academic self-confidence in math and science skills.

		Incoming		Outgoing	
		Average	*Standard Deviation*	*Average*	*Standard Deviation*
Commitment to Completing Degree		0.92	0.12	0.93	0.11
Confidence in Completing Degree		0.88	0.17	0.91	0.14
Academic Self-Confidence	**Problem-Solving**	0.83	0.11	0.84	0.11
	Math & Science Skills	0.84*	0.11	0.79*	0.13

	Professional & Interpersonal Skills	0.80	0.14	0.82	0.11
Self-Efficacy	Engineering	0.76	0.10	0.78	0.06
	Tinkering	0.76	0.10	0.78	0.07

Table 1. Students' confidence and self-efficacy before and after the project course in a small private college.
*indicates $p<0.05$ by unpaired, two-tailed t-test.

This decrease could be due to the fact that students spent a very small proportion of their time in the project course engaged in math and science tasks (see the following section), or could be due to a different course, such as students being concurrently enrolled in a difficult math class that decreases their confidence in their abilities. It could also be due to students experiencing a shift in peer group, from a high school cohort where they were unusually high performers in math and science, to a college cohort that is entirely composed of these high performers. Previous work has found that engineering students' confidence in math and science skills does not increase over the four years of their program (when their skills are presumably increasing); this may similarly be a result of comparing themselves to their peers.[33] This is also in line with evidence that high performers in a field underestimate their competence, in part because they assume that their peers are equally competent.[40]

However, when the incoming and outgoing confidence and self-efficacy measures were broken out by gender, some significant differences emerged (Table 2). At the start of the course (that is, at the start of their engineering program), women had a lower commitment to completing their degree, confidence in completing a degree, and academic self-confidence in math and science skills and in professional and interpersonal skills (p-values of 0.014, 0.018, 0.003 and 0.003, respectively) than men. The difference in their incoming engineering self-efficacy compared to their male counterparts verged on significance ($p=0.052$). When comparing the outgoing measures, there is a statistically significant difference in academic self-confidence in math and science skills between male and female students ($p=0.006$) and only female students experienced a significant decrease in their self-confidence in this area ($p=0.031$).

		Female				Male			
		Incoming		Outgoing		Incoming		Outgoing	
		Average	*Standard Deviation*	*Average*	*Standard Deviation*	*Average*	*Standard Deviation*	*Average*	*Standard Deviation*
Commitment to Completing Degree		0.88*	0.14	0.92	0.12	0.97*	0.08	0.95	0.09
Confidence in Completing Degree		0.82*	0.21	0.88	0.14	0.95*	0.09	0.97	0.08
Academic Self-Confidence	**Problem-Solving**	0.80*	0.12	0.81	0.12	0.88*	0.08	0.88	0.08
	Math & Science Skills	0.80*	0.12	0.75*	0.12	0.89*	0.06	0.84*	0.13
	Professional & Interpersonal Skills	0.79	0.14	0.82	0.11	0.81	0.13	0.81	0.11
Self-Efficacy	**Engineering**	0.74	0.09	0.77	0.07	0.79	0.10	0.80	0.05
	Tinkering	0.75	0.12	0.76	0.09	0.78	0.08	0.79	0.05

Table 2. Male and female students' confidence and self-efficacy before and after the project course in a small private college.
*indicates $p<0.05$ by unpaired, two-tailed t-test.

The difference between male and female students in their incoming measures is in line with a model of self-efficacy in which role models and social affirmation play a significant role[1]: women have fewer role models in engineering than their male counterparts, and often do not receive the same social affirmation as men. Preliminary analysis of qualitative data supports this: in the post-course interviews, when students were asked about who they looked up to, many students cited that their father was an engineer, whereas very few mentioned role models who were female engineers. Students were also asked “How do people react when they find out you are in engineering?” Male students gave fairly neutral responses: “…I kind of grew up with engineering, so it's not that much of a shock, and they're like, you'd be a good engineer.” Female students, however, often had a different experience, as this response illustrates:

> Funny story there… the guy driving the shuttle found out I was in engineering. He goes, "Wait, you're an engineer?" And the implication was you're a woman studying engineering, and I was very, very surprised that that happened…when I got off, I was walking by [a student] who's my friend, and they were hanging out there to wait for the [campus] shuttle. And I was like, "The guy was absolutely shocked that I was a female engineer. He couldn't handle it." I mean, because he repeated that a few times. He's like, "You're a woman studying engineering." I mean, it's just mind-blowing for him, and it was mind-blowing for me that he didn't see that as being a possibility. and it sort of made me sad, but…in some ways it was good just to be able to say, "Yes, I'm an engineer," and leave it at that.

Relationships between Confidence and Self-Efficacy Measures and Project Tasks

Analyzing the students’ weekly activity logs gave insights into how students were spending their time. We considered both the proportion of time students spent on tasks (the total number of minutes devoted to a task cluster divided by the total number of minutes reported to have been spent working on the project throughout the semester) and the average time spent on tasks (the average time spent on a task cluster in each week). Investigating the statistical correlation between the survey measure data and the activity log data allowed for investigation of the following additional research questions:

3. Was there a relationship between the tasks students engaged in and their incoming confidence and self-efficacy measures?
4. Did any tasks correlate to observable changes in confidence or self-efficacy measures?

Figures 1 and 2 show how students spent their time on the project course, divided by the activity and mastery clusters, respectively. As seen in Figure 1, students spent the largest proportion of their time on hands-on work (32%), brainstorming (13%), modeling/CAD (10%), and oral presentations (9%).

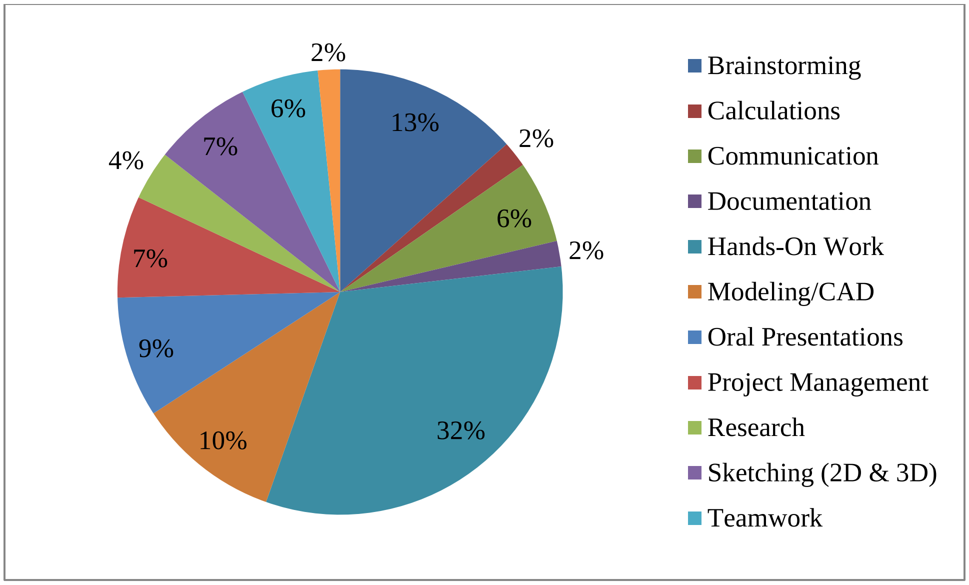

Figure 1. Overall proportion of time spent in activity clusters.

Figure 2 shows how students spent their time in each of the mastery clusters. Students spent the least amount of time on tasks in the academic self-confidence in math and science skills mastery cluster (7.1%) and most of their time engaged in tasks in the engineering task cluster (57.6%) and tinkering task cluster (49.1%). It is important to note that there is considerable overlap in the tasks between these two clusters, as the engineering task cluster also includes hands-on engineering tasks.

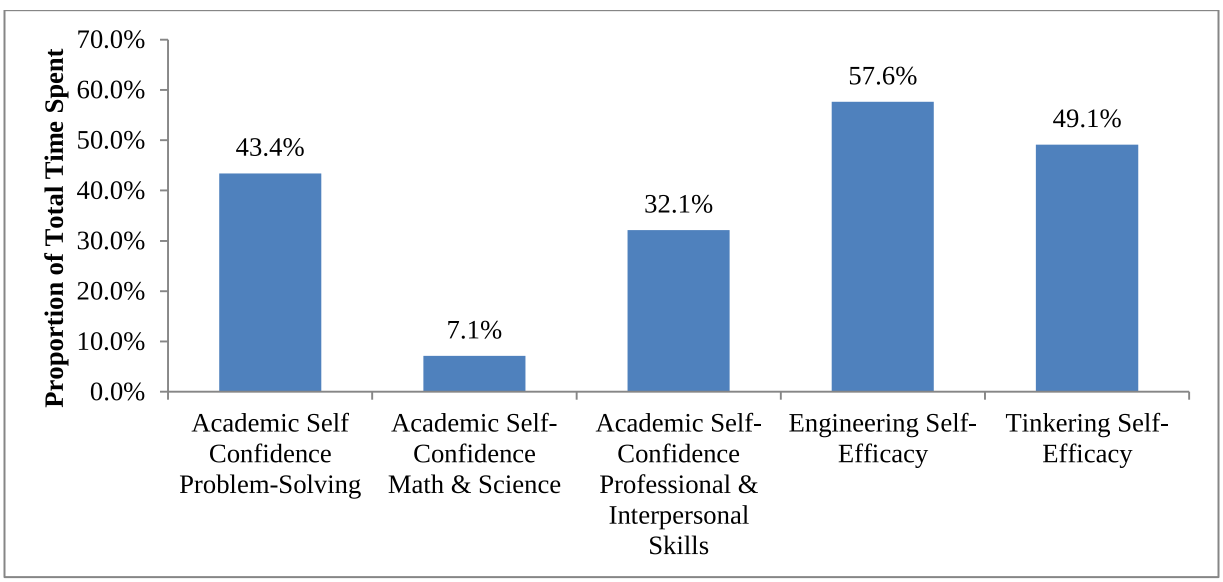

Figure 2. Overall proportion of time spent in mastery clusters for all students.
Percentages do not add up to 100% because certain tasks are in more than one cluster.

Based on these preliminary analyses, there is little evidence that the incoming confidence or self-efficacy in a particular area was the principal determinant of the *choice* of tasks that students engaged in, as there were no significant correlations between measures and the proportion of time spent on corresponding tasks. Students did, however, on average spend *more time on tasks* compared to their peers based on their self-efficacy levels: there was a statistically significant correlation between incoming engineering self-efficacy and the average time spent on engineering tasks (p=0.016) and tinkering self-efficacy and the average time spent on tinkering tasks (p=0.004). Therefore, it appears that students do not necessarily choose to work on tasks in which they are already confident, but they may devote more time to tasks in which they have higher self-efficacy. There was also a significant *negative* correlation between students' incoming academic self-confidence in professional and interpersonal skills and proportion of time spent on those tasks (p=0.022); in other words, students who were already confident in their professional skills (communication, teamwork) spent less of their time on those tasks (preparing an oral presentation, working on a written report). This is likely consistent with the learning goal intervention described previously,[26] in which students were asked to identify, articulate, and engage in tasks that were consistent with their learning goals for the project.

Next, we investigated if there were any project tasks that led to a significant change in any confidence or self-efficacy measures. The purpose of exploring this question is to determine where students might be encouraged focus their time in projects; if we can conclude that students receive a high increase in tinkering self-efficacy by spending a lot of time in the machine shop, for example, students should be encouraged to spend their time there. There were correlations between the change in engineering self-efficacy and average time spent on tinkering self-efficacy tasks (p=0.011), which means that students with a higher increase in engineering self-efficacy spent a good deal of time on different hands-on tasks. There was a negative correlation between change in engineering self-efficacy and proportion of time and average time spent on academic self-confidence in math and science tasks (p-values of 0.010 and 0.014, respectively), meaning students who had a higher change in engineering self-efficacy spent less time overall and on average on math and science tasks. In other words, students who had the highest change in engineering self-efficacy spent a lot of time on tinkering tasks and less time on math and science tasks.

There were also several observed Pearson's correlations between outgoing tinkering self-efficacy and task selection, but not between any other confidence or self-efficacy measures. Exiting tinkering self-efficacy levels correlated to the total time spent on tasks (p=0.021), proportion of time spent on math and science tasks (p=0.011), and average time spent on problem-solving tasks (p=0.049), math and science tasks (p=0.001), engineering self-efficacy tasks (p=0.007) and tinkering tasks (p=0.002). Predictably, exiting tinkering self-efficacy also correlates strongly with entering tinkering self-efficacy ($p<<0.001$) so it cannot be necessarily concluded that these tasks lead to a high tinkering self-efficacy; it may be more that they are taken on because students are already comfortable with tinkering.

Project Experiences at Large Public Schools

Change in Confidence and Self-Efficacy Measures throughout the Project Course

To examine an engineering project experience in more traditional undergraduate programs, we also investigated survey data from students at large public universities, as shown in Table 3. Over the course of the semester, almost all measures increased somewhat, but there was a statistically significant increase in three measures: academic self-confidence in problem-solving, academic self-confidence in professional and interpersonal skills, and tinkering self-efficacy (p-values of 0.034, 0.028, 0.0187, respectively). Although there are certainly many other factors that may contribute (other courses, personal experiences), it appears that this hands-on engineering project could be a factor in increasing students' confidence levels.

		Incoming		**Outgoing**	
		Average	*Standard Deviation*	*Average*	*Standard Deviation*
Commitment to Completing Degree		0.89	0.21	0.88	0.20
Confidence in Completing Degree		0.82	0.19	0.90	0.14
Academic Self-Confidence	**Problem-Solving**	0.82*	0.08	0.87*	0.06
	Math & Science Skills	0.80	0.11	0.83	0.10
	Professional & Interpersonal Skills	0.80*	0.13	0.88*	0.08
Self-Efficacy	**Engineering**	0.72	0.10	0.81	0.10
	Tinkering	0.74*	0.09	0.80*	0.09

Table 3. Students' confidence and self-efficacy before and after the project course in large public schools. *indicates $p<0.05$ by unpaired, two-tailed t-test.

The only significant difference between these students and the ones in the previous dataset was that the outgoing academic self-confidence in professional and interpersonal skills in large public universities was higher than those in the small private college (p=0.036). However, differences in the datasets emerged when comparing incoming and outgoing measures and measures between male and female students.

No statistically significant differences were observed between any of the measures for male and female students, for neither incoming nor outgoing data, as shown in Table 4. However, this is in itself surprising; it suggests that some gender gaps that have been previously reported for undergraduate engineering students may be narrowing, for a variety of possible reasons.[27,33] For example, in this data set, shown in Table 4, women have generally higher confidence and self-efficacy levels in many measures; the incoming tinkering self-efficacy of women is trending towards being higher than their male counterparts (p=0.063).This may be due to women being more likely to go into engineering if they see themselves as having an exceptionally high aptitude and ability for hands-on work or math and science skills, while this is not a necessary prerequisite for men. However, when using paired t-tests to compare the pre- and post-course data for each gender, there is a statistically significant increase in the male students' tinkering self-efficacy, which is in line with previous studies that found that male students may benefit more from project work.[27]

		Female				Male			
		Incoming		Outgoing		Incoming		Outgoing	
		Average	*Standard Deviation*	*Average*	*Standard Deviation*	*Average*	*Standard Deviation*	*Average*	*Standard Deviation*
Commitment to Completing Degree		0.95	0.09	0.95	0.09	0.84	0.26	0.82	0.24
Confidence in Completing Degree		0.84	0.15	0.90	0.15	0.81	0.23	0.90	0.14
Academic Self-Confidence	**Problem-Solving**	0.82	0.10	0.88	0.08	0.82	0.06	0.86	0.05
	Math & Science Skills	0.81	0.10	0.88	0.08	0.79	0.12	0.79	0.10
	Professional & Interpersonal Skills	0.76	0.16	0.90	0.06	0.83	0.10	0.87	0.09
Self-Efficacy	**Engineering**	0.69	0.09	0.84	0.13	0.74	0.11	0.79	0.07
	Tinkering	0.75	0.08	0.82	0.12	0.74*	0.11	0.79*	0.05

Table 4. Male and female students' confidence and self-efficacy before and after the project course in large public schools. *indicates $p<0.05$ by unpaired, two-tailed t-test.

Similarly, while comparing the outgoing confidence and self-efficacy levels, women generally report higher levels than men for academic self-confidence in both math and science skills and professional and interpersonal skills ($p= 0.084$ and $p=0.056$, respectively). After a semester of working in engineering, female students may become more confident because they are succeeding and feeling reaffirmed in their decision to enter engineering or, conversely, because they are facing adversity as a minority in a stereotypically male field, therefore must be more self-assured in order to take on the perceived challenge.[41] Although it is encouraging to see that female students may be becoming as or more confident than their male counterparts (in contrast with previous studies that suggest that female students do not benefit as strongly from project work[27]) this may simply mean that engineering programs are selecting strongly for high-performing women with high self-confidence, rather than women who are more comparable to their male counterparts, which is itself an indication that students expect to have strongly gendered experiences in engineering programs.

Relationships between Confidence and Self-Efficacy Measures and Project Tasks

This preliminary dataset is very small and work is ongoing, but it does provide solid motivation for continued work in this area: investigating the activity logs to determine which tasks students engage in and how their choice of tasks affects their confidence levels, as well as conducting more interviews to gain additional nuance and insight into the students' experience working in teams on an engineering design project.

Preliminary Conclusions and Future Work

Investigating data from different universities with different project experiences affords insight into how students are currently working in team projects and how these experiences affect their confidence and self-efficacy. In an extensive semester-long project at a smaller school, students experienced a decrease in academic self-confidence in math and science skills over the course of the project. Female students began the semester with lower confidence and self-efficacy in several measures, but by the end of the project, there were minimal differences between gender groups. Students did not appear to select their project tasks based on their incoming confidence levels. However, there were some correlations between change in confidence levels and tasks: students who had the highest change in engineering self-efficacy spent a lot of time on tinkering tasks and less time on math and science tasks. In larger schools with more typical engineering projects, students experienced increases more confidence and self-efficacy measures over the course of the project and there were fewer significant gender differences. Investigating the activity log data and conducting more interviews at these schools will provide further insight.

The findings presented here are emerging results from an ongoing analysis and also provide many opportunities for future direction. In addition to collecting more data from a wider variety of students, there are research questions that can be further investigated. It's already clear that the interactions between self-efficacy, activities, gender, team dynamics, learning environment, and larger social environment are complex. While the results here are in general agreement with previous studies regarding academic self-confidence and how it is affected by gender and over the course of the engineering program, there is a significant amount of work yet to be done to continue to explore how different measures of self-efficacy relate to tasks undertaken (mastery experiences), and how they are affected by larger factors such as gender schemas. In particular, analysis of semi-structured interviews is beginning to provide a more nuanced view into how students view their teaming experiences and may provide insight into the effects of team dynamics and team roles on confidence, self-efficacy and the selection of project tasks. For example: If students are not selecting project tasks based on their incoming confidence levels, how are students selecting tasks? Quantitatively, there was no correlation between gender and tasks completed, but qualitative data presents a different view. For example, male students often mention spending a great deal of time on technical engineering work, while female students mention more non-technical tasks. When responding to the question "were there any activities that you did more of than you would like?" a female student responded: "Arts and crafts. We did a lot of that. We did a lot of painting. And also shopping." This also suggests that student perceptions of their activities may differ from their reported activities, which suggests that their emotional relationship to different types of task may play a role in their experience.

Also, even if there is no direct effect of engagement in particular tasks on related self-confidence or self-efficacy measures, might they have other effects? Or, if mastery experiences are not greatly impacting these measures, what does have the most effect on the confidence and self-efficacy? Further quantitative analysis (regressions, ANOVA, factor analysis) may determine if the outgoing confidence and self-efficacy levels depend more on the incoming confidence levels or the mastery experiences (i.e. students with higher outgoing confidence may be the students with the higher incoming confidence, regardless of tasks completed).

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