

Student perceptions of confidence in learning and teaching before and after teaching improvements

As part of an overall research program investigating the impact of changes in teaching strategies on students' engineering social cognitions (self-efficacy and outcome expectations), this paper investigates students' confidence in their ability to learn and their instructor's ability to teach across 6 engineering courses. A group of 6 faculty formed a learning community focused on improved teaching strategies for their classes. The faculty chose selected strategies and implemented them in their classes. Surveys asked students to rank their confidence level in "their ability to learn" the specific class material and the instructor's "ability to teach" the class material using a sliding bar scale from 0-100. Surveys were conducted before and after the improvements to the teaching strategies at both the beginning and end of the semesters. The results of the surveys are compared before and after the teaching improvements, beginning to end of semester, per course, online to in-person, and per gender. In summary, the study found that while there was no significant difference in the control group, a decrease in students' confidence to learn and in their confidence in their instructors' ability to teach was observed in the treatment group. This decrease was observed in specific courses that changed instructional modes due to Covid. Despite teaching improvements, students' confidence decreased as they moved through the course material. Further research is needed to explore these findings and their implications for teaching strategies.

Introduction

This paper investigates student's perception of confidence in their ability to learn a particular course's material and their confidence in the instructor's ability to teach the material. The paper is part of an overall larger project investigating if changes in teaching practices can change student self-efficacy in engineering [1]. Therefore, the following gives a background on self-efficacy, and relates it to students' confidence in their learning and to their instructors' teaching. Also, the following explains how teaching practices can influence students' confidence.

Self-efficacy theory, which has a significant impact on how students view their own abilities as learners, emphasizes that people's confidence in performing a certain task depends on four types of experience: previous success, verbal encouragement, observational feedback and physical feedback. Research has proven that students' academic confidence affects their performance successfully. For example, a structural equation modelling based on 636 observations showed the evidence that students' confidence affect their academic performance significantly [2]. In addition, a study [3] measured students' self-confidence by collecting quantitative questionnaire from 1375 students and found students' self-confidence effected their learning goals, interests, and their anxiety. One study[4] collected data from the 86,000 students evaluations on their instructors' teaching practices at the University of Girona (Spain) during three years, and a total of 1832 teachers were evaluated. The findings indicated that students'

achievement is high related to students' confidence which was interpreted as self-efficacy by authors.

One approach to increase students' confidence in learning is changing instructor's practices. Bartimote-Aufflick [5] gave examples that teaching strategies can be used to improve students' self-efficacy. Walker [6] gives various instructional procedures to enhance students' self-efficacy in reading and writing. For example, if teachers conduct appropriate teaching strategies such as giving a choice, creating self-evaluations, and changing the assessment context can help students maintain positive self-efficacy. Researchers [7] in social work indicated that social work students' self-efficacy extended when instructors used strategies including building a supportive classroom environment and creating emotional, cognitive, and action-focused activities. Zhang[8] assessed the effects of teacher enthusiasm on students' academic self-efficacy from 165 college students in a basic communication class. The results indicated that teachers' enthusiasm had power on students' self-efficacy significantly.

Regarding the teaching strategies in engineering education, one study [9] found that the demonstration strategy of teaching was more effective than the lecture strategy in improving students' performance in engineering education. The study also found that teaching experience had a significant effect on students' performance. This study showed the importance of adopting appropriate teaching methods in engineering education. Another study [10] discussed project-based learning and SCAMPER teaching strategies. The results showed appropriate teaching strategies improve students' ability to face engineering problems. A study [11] introduced the effectiveness of reading textbooks before solving engineering design problems. The findings suggested that encouraging students to read the textbook before giving questions can improve students' understanding of class materials. Problem-based learning (PBL) method is an effective strategy to affect students' self-efficacy in engineering education. One study [12] indicated that PBL was an valuable teaching approach for helping computer science students develop the confidence and competence they need to succeed as software developers in the workplace. Thus, we assume that adopting appropriate teaching strategies in engineering classrooms can increase students' confidence in completing courses and working on degrees in engineering fields.

Furthermore, several academic articles that discuss teaching strategies that can help change students' confidence on learning. Research shows that the learning environment and teaching method can improve students' self-efficacy in the classroom [13]. For example, according to Bandura [14], cooperative learning strategies can improve both self-efficacy and academic achievement. Fencil and Scheel [15] reported that a non-majors' physics course had a positive classroom climate and increased self-efficacy when using appropriate teaching methods such as collaborative learning and electronic applications. These teaching practices were found to have a positive relationship with higher self-efficacy among students in the study. Margolis and McCabe provided suggestions that to increase students' confidence on academics success, several

teaching strategies can be conducted such as using moderately-difficult tasks, using peer models, allowing students to make own choices, and so on.

While the previous literature supports the assumption that teaching practices can influence students' self-efficacy and thereby confidence, this paper is investigating a small part of an overall research study and looking into two simple questions on student's perceptions of their ability to learn and the instructor's ability to teach. The authors assume changes in these perceptions would indicate possible changes in self-efficacy that will be investigated in future work. Therefore, in this paper, we are considering on the research question: Do improvements to teaching practices affect student perceptions of their own learning ability and their instructors' ability to teach?

Method

A group of 6 faculty members participated in a learning community to receive training and discuss the teaching practices in their engineering classes. The teaching practices were targeted to the four types of learning experiences in the SCCT model. Faculty received the training to learn how to use those teaching practices and were given examples on using the practices. Figure 2 shows a screenshot of the Canvas page for the learning community. Table 1 shows the basic introductory information of faculty in the learning community and describes the course they were teaching. Details of the teaching practices instructors used and why they choose them for their classes is given in [16].

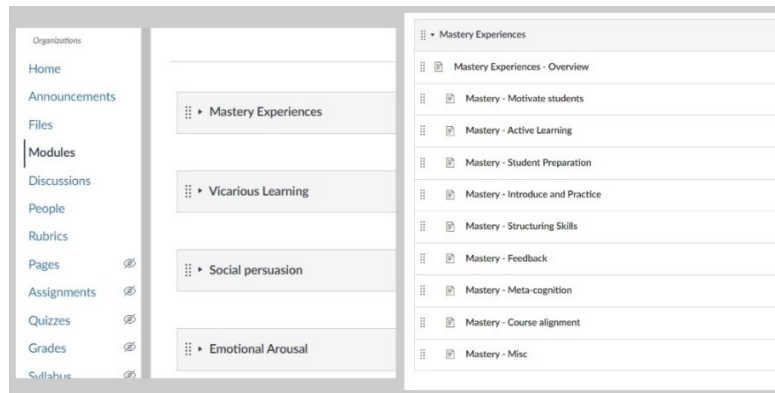


Figure 2 Online Resources on Canvas for the Engineering Faculty Learning Community

Table 1 Faculty and Course Descriptions

Course Number	Course Level	Instructor level	Department	Instruction Mode Fall 2020	Instruction Mode Fall 2021
1	So..	Asst. Prof	Engr.	Online	In-person
2	Jr.	Asst. Prof	Civil	Hybrid	In-person
3	Jr.	Prof.	Mech.	In-person	In-person
4	So.	NTT	Info. Tech.	Online	Online
5	Jr.	Assoc. Prof	Chemical	In-person	In-person
6	Sr.	Prof.	Chemical	In-person	In-person

The study was divided into two time periods: the Fall 2020 semester and the Fall 2021 semester. In the Fall 2020 semester, 6 faculty attended training and were not required to implement new teaching practices. This semester served as the control group. Although, it is worth noting that the impact of COVID moved some of the classes online rather than in their traditional in-person format and impacted the overall student emotional state. This impact likely influenced the results in this study. In the Fall 2021 semester, faculty members were requested to choose certain practices they thought suitable for their classes and implement them. Meanwhile, the faculty members were invited to meet monthly to share their challenges, achievements, and solutions. The authors documented the strategies they were using new and recorded the feedback from the faculty [16]. This semester was considered the treatment group.

In this study, authors adopted a pre & post-design to deliver a student survey at 2-time points. In each study group, student participants were invited to complete a pre-survey during the first two weeks of that semester and a post-survey during the final two weeks of that semester. Table 2 explains the pre & post-design.

Table 2 Research Design

	Control Group Fall 2020		Treatment Groups Fall 2021	
Student	Pre-survey	Post-survey	Pre-survey	Post-survey
Faculty	<ul style="list-style-type: none"> • Attended Trainings • Did not use new strategies 		<ul style="list-style-type: none"> • Discuss challenges/feedback • Used new strategies 	

In each survey, students were asked to use a sliding scale bar to show their level of confidence in a specific course. In the scale, 0 means "*Not at all Confident*", and 100 means "*Very Confident*". The instruction was "Use the sliding scale bar below to show your LEVEL OF CONFIDENCE for learning in this specific course." The first question was "...you will be able to learn this class's material" and the second question was "...your instructor will be able to effectively teach the class material?" In the post survey, the verbs were adjusted as a past tense.

Participants consisted of students from the college of engineering at a public land grant university in the Midwest. All students enrolled in engineering courses which were taught by the 6 faculty in the engineering faculty learning community. A total of 224 matched participants completed both the pre and post-survey in the control group (Fall 2020), and 286 participants completed the pre and post-survey in the treatment group (Fall 2021). Table 3 presents the sample size, and the participants' demographic information. Please note that not all participants provided their background information.

We compared the mean results from the pre and post data and used paired t-tests in R to estimate the differences between pre and post in the control and treatment group separately.

Table 3 Demographic Information of Participants

Item		Fall 2020		Fall 2021	
Sample Size		224		286	
Age Mean		19.83		20.10	
		N	%	N	%
Instruction Model	Both online	17	7.6	/	/
	In-person	41	18	197	69
	Online	166	74	39	14
Race	White/European American	191	85	241	84
	Black/African American	11	4.9	16	5.6
	Latinx/Hispanic	6	2.7	4	1.4
	Asian/Asian American	6	2.7	15	5.2
	Biracial/Multiracial	5	2.2	7	2.4
	Other	3	1.3	3	1.0
Gender	Woman	79	35	69	24
	Man	145	65	215	75
	Other	N/A	N/A	2	0.7
Class Standing	First-Year	23	10	35	12
	Sophomore	104	46	120	42
	Junior	73	33	102	36
	Senior	18	8.0	21	7.3
	Other	5	2.2	8	2.8
Program	Chemical Engineering	37	17	60	21
	Biological Engineering	2	0.9	2	0.7
	Biomedical Engineering	24	11	27	9.4
	Civil and Environmental Engineering	76	34	56	20
	Electrical Engineering	5	2.2	8	2.8
	Computer Engineering	1	0.4	3	1.0
	Industrial and Manufacturing Systems Engineering	4	1.8	3	1.0
	Information Technology	11	4.9	29	10
	Mechanical Engineering	57	25	83	29
	Undeclared Engineering	4	1.8	5	1.7
	Other	3	1.3	10	3.5

Results

Students' Confidence in Learning Class Material

We focused on the matched participants who completed both pre- and post-survey for both groups (see Table 4). There was no significant difference between the pre and

post surveys in the control group. However, significant change was present in the treatment where faculty members conducted the appropriate teaching strategies, $t(285) = 5.31, p < .001$ and the mean decreased by 6.05. It would seem that despite teaching improvements, there was a decrease in the student's confidence to learn the material. However, when looking at the control group data in Fall 2020 the mean confidence level ($M=67$) is much lower than the treatment group ($M=79$). It may be that in the semester after the Covid shutdown students started out less confident. While in Fall 2021, the students started out with a high level of confidence that then decreased as they moved through the course material. It is also worth noting that the mean post of the treatment group ($M=73$) is higher than the mean post of the control group ($M=67$) indicating perhaps a higher confidence in the treatment group at the end of the semester.

Table 4 Students' Confidence on Learning Class Material

Group	Item	Value
Control Group	P value	0.98
	Mean in Pre	67
	Mean in Post	67
	N	223
Treatment Group	P value	< 0.001
	Mean in Pre	79
	Mean in Post	73
	N	285

Then we specifically explore the difference among different courses. The results are similar to the results for all participants, but some trends emerge for specific courses. For both course 1 and 2, which were online or hybrid in 2020 but moved back to in-person in 2021 there was a significant decrease in the treatment group. Course 5 showed a significant decrease in the control group ($p < .05$) but not in the treatment group. Courses 3, 4, and 6 showed no significant change in the treatment or control groups. The only courses that showed a significant change in the treatment group were course whose instructional mode was altered in Fall 2020. Again, the means of the pre-survey in the Fall 2020 semester were much lower than the means in the Fall 2021 semester (for course 1 $M=68$ in Fall 2020, and $M= 81$ in Fall 2021). It is likely that the sudden change in instructional mode for those classes resulted in much less confidence in Fall 2020.

Table 5 Students' Confidence on Learning Class Material in Each Course

	Course Item	Course 1	Course 2	Course 3	Course 4	Course 5	Course 6
Control Group	P value	0.51	0.02*	0.21	0.26	0.04*	0.20
	Mean in Pre	68	74	47	73	75	67
	Mean in Post	70	61	61	82	61	59
	N	116	15	8	11	13	23
Treatment Group	P value	< 0.001***	0.01*	0.46	0.92	0.61	0.61
	Mean in Pre	81	79	71	78	80	80
	Mean in Post	70	71	77	78	76	79
	N	135	33	14	37	23	38

Note. ns $p > 0.05$, * $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$, **** $p \leq 0.0001$

Students' Confidence on Instructors' Teaching Class Material

Table 6 gives the results for the student's confidence in the instructor's ability to teach the class material for the participants who completed pre and post surveys in control or treatment groups. In the control group, there was no different between pre and post surveys ($p > .05$). On the contrary, statistic decrease by 5.73 was discovered in the treatment group, $t(285) = 6.34$, $p < .001$. This was similar to the result in the student's ability to learn.

Table 6 Students' Confidence on Teaching Class Material

Group	Item	Value
Control Group	P value	0.75
	Mean in Pre	68
	Mean in Post	68
	N	223
Treatment Group	P value	< 0.001***
	Mean in Pre	81
	Mean in Post	75
	N	285

Note. ns $p > 0.05$, * $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$, **** $p \leq 0.0001$

Similar to the students' confidence in their learning ability, a significant decrease was noticed in both the treatment groups for courses 1 and 2, but not the other courses. In the control semester, there was a decrease for course 2 ($p < .0003$) and course 3 ($p < .05$). Again the mean pre-survey scores were much lower in Fall 2020 than Fall 2021 indicating a possible impact due to Covid.

Table 7 Students' Confidence on Instructors' Teaching in Each Course

	Course Item	Course 1	Course 2	Course 3	Course 4	Course 5	Course 6
Control Group	P value	0.14	0.003**	0.04 *	0.73	0.24	0.13
	Mean in Pre	67	74	44	67	80	69
	Mean in Post	71	55	63	68	71	59
	N	116	15	8	11	13	23
Treatment Group	P value	0.001**	0.006*	0.51	0.13	0.06	1
	Mean in Pre	80	82	66	80	92	82
	Mean in Post	74	71	70	75	85	82
	N	135	33	14	37	23	38

Note. ns $p > 0.05$, * $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$, **** $p \leq 0.0001$

Gender Differences

When examining gender differences regarding confidence in students' learning ability (Table 8), there was no change in the control group ($p > .05$). However, changes were found in the treatment group for both males and females. There was a decrease in the treatment group between pre ($M = 80$) and post survey ($M = 74$) for males, $t(214) = 4.32$, $p < .001$. In addition, a greater decrease was found for females between pre ($M = 78$) and post survey ($M = 70$), $t(68) = 3.17$, $p < .01$.

Table 8 Students' Confidence on Learning Class Material Based on Gender

	Course Item	Male	Female
Control Group	P value	0.34	0.32
	Mean in Pre	68	65
	Mean in Post	67	68
	N	144	78
Treatment Group	P value	< 0.001***	0.002**
	Mean in Pre	80	78
	Mean in Post	74	71
	N	214	68

Note. ns $p > 0.05$, * $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$, **** $p \leq 0.0001$

Respecting for gender differences regarding students' confidence on their instructors' teaching (Table 9), it is apparent that males' confidence decreased in the treatment groups, $t(214) = 4.52$, $p < .001$. The changes on female students were not visible when treatment given.

Table 9 Students' Confidence on Instructors' Teaching Based on Gender

	Course Item	Male	Female
Control Group	P value	0.95	0.67
	Mean in Pre	66	70
	Mean in Post	67	71
	N	144	78
Treatment Group	P value	< 0.01**	0.30
	Mean in Pre	82	79
	Mean in Post	75	77
	N	214	68

Note. ns $p > 0.05$, * $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$, **** $p \leq 0.0001$

Differences in the Instruction Models

Table 10 shows the students' confidence on learning class material based on instruction models. The table compares the mean scores of students' confidence in pre- and post-tests for online, in person, and hybrid courses. The table also reports the p-values and N of matched participants for each instruction model. The results indicate that there was no significant difference in students' confidence for online courses between control and treatment groups ($p = 0.4932$). However, there was a significant difference for in-person courses ($p < 0.001$) with treatment group having lower mean scores than control group in both cases.

Table 10 Students' Confidence on Learning Class Material Based on Instruction Model

	Course Item	Online	In Person	Hybrid
Control Group	P value	0.35	0.52	0.24
	Mean in Pre	68	63	70
	Mean in Post	70	60	61
	N	165	40	16
Treatment Group	P value	0.4932	< 0.001**	/
	Mean in Pre	79	79	/
	Mean in Post	77	73	/
	N	38	196	/

Note. ns $p > 0.05$, * $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$, **** $p \leq 0.0001$

Table 11 shows the students' confidence on instructors' teaching based on instruction model. The results indicate that there was no significant difference in students' confidence for online courses between control and treatment groups ($p = 0.12$). However, there was a significant difference for in person courses ($p = 0.007$) with treatment group having lower mean scores than control group in both cases.

Table 11 Students' Confidence on Instructors' Teaching Based on Instruction Model

	Course Item	Online	In Person	Hybrid
Control Group	P value	0.22	0.586	0.17
	Mean in Pre	68	64	71.18
	Mean in Post	70	62	60
	N	165	40	16
Treatment Group	P value	0.12	0.007**	/
	Mean in Pre	80	80	/
	Mean in Post	75	76	/
	N	38	196	/

The tables suggest that the treatment group had lower confidence on learning class material and instructors' teaching than the control group for in-person courses, but not for online courses.

Discussion

The results of this study suggest that enhancing teaching strategies may not always result in an increase in students' confidence in their ability to learn the course material or in the instructor's ability to teach. These findings challenge the notion that effective teaching practices always lead to positive student confidence.

One possible explanation for the unexpected results could be that the COVID-19 pandemic or online engineering classroom impacted the students' learning experiences. In one previous report, students faced various challenges during online learning[17], and those concerns may affect their confidence on their ability to perceive their own and the instructor's performance. The data from this study did show that the mean pre-survey scores were lower in Fall 2020 than in Fall 2021. Additionally, it is possible that the teaching strategies applied were not the right fit for the particular course or that they were not implemented effectively. Thus, further research related to the fidelity of teaching practice is necessary. Finally, it may be that student's perceived confidence in learning engineering material naturally decreases as the semester progresses.

Overall, the results of this study imply that the influence from teaching strategies to student confidence is complex, and that there may be factors beyond teaching strategies. Further research is needed to gain a better understanding of this relationship and to identify effective teaching strategies that can improve student confidence of their ability to learn and the instructor's ability to teach.

Conclusions

In this study, we collected data from control and treatment groups to evaluate if the enhancement of teaching strategies can affect students' perception of their ability to learn course material or in the ability of the instructor to teach the course material.

The results of this study indicate that there was no significant difference between pre and post surveys in the control group. However, a significant decrease in students' confidence to learn the material was observed in the treatment group where faculty members conducted appropriate teaching strategies. This decrease was also observed in students' confidence in the instructor's ability to teach the class material. When looking at specific courses, a significant decrease was only noticed in courses 1 and 2 which were the only courses that switched instructional mode from Fall 20 to Fall 21. Furthermore, the pre-survey means were lower in Fall 2020 than in Fall 2021, possibly due to impacts from Covid.

When examining gender differences regarding confidence in students' learning ability and instructors' teaching ability, changes were found in the treatment group for both males and females. Males' confidence decreased significantly in both their learning ability and their instructors' teaching ability while changes on female students were only visible when it comes to their learning ability.

The results also indicate that there was no significant difference in students' confidence for online courses between control and treatment groups. However, there was a significant difference for both in-person courses with treatment group having lower mean scores than control group.

These results suggest that despite teaching improvements, students' confidence decreased as they moved through the course material. While it was expected to see an increase in student perceptions of their ability to learn and the instructor's ability to teach when teaching improvements were applied, the results do not show the expected changes. The effect of the Covid semester or the lack of impact of the teaching practices on the overall class may have confounded the data. Additional analysis is needed that includes the self-efficacy scores and qualitative results of the survey to determine which factors were the strongest drivers for changes in student perceptions.

Future Work

The study reported in this paper is a component of a comprehensive research endeavor that is exploring the impact of modifications in teaching approaches on students' social cognitions (such as self-efficacy and outcome expectations).

From our results, we can see students' confidence decreased in several courses from pre survey to post survey. We observed the faculty's classes and delivered open-end questions to understand students' experience with various teaching strategies. Also, the feedback from open-ended questions could be used to understand the differences of changes between students starting from high level confidence and students starting from low level confidence. Furthermore, we are exploring if the different teaching strategies are useful for students on offering a positive effect on personal performance accomplishments, vicarious learning, social persuasion, and physiological and affective states. Also, we are examining the fidelity of those instructors' teaching. Those analyses will provide a deeper understanding of the efficacy of teaching techniques. In the future, we will present a summary of our findings combining all the results.

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