Investigating S-STEM Financially Supported Students' Change-Readiness and Self-Efficacy and the COVID-19 Impact: A Longitudinal Study

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Abstract

A student's preparation and readiness to initiate and respond to changes in the constantly-changing environment is important for student success in their academic achievement and life satisfaction. Students' choice of taking tasks and their perseverance when doing them can be influenced by their self-efficacy. Students who are financially needy underserved and underrepresented are often at a disadvantage in their attendance, persistence, self-confidence, self-efficacy, and willingness to remain in STEM. And previous research has found that specialized programs to support their development and progress has been beneficial in student retention, intents to persist and professional skill development.

The Engineering Technology Scholars – IMProving Retention and Student Success: (ETS-IMPRESS), implemented at Michigan Technological University (MTU), provides financial and academic assistance to underrepresented students in S-STEM programs to increase their chances of academic and professional success. Previous findings have suggested that transfer students participating in ETS-IMPRESS are less prepared and have lower self-efficacy levels compared to non-transfer students participating in a comparative scholarship program.

This study focuses on one previous research finding, reporting challenges critical for ETS-IMPRESS students: having lower ratings in their change-readiness level (e.g., optimism and adventurousness) and approaching a significantly lower rating in their feeling of inclusion in the subscale of self-efficacy, compared to other students participating in the same Honors Program. We conducted a pretest/posttest (baseline vs. most recent follow-up) and longitudinal study design to examine how student skill development outcomes, such as student self-efficacy, change-readiness, and intent to persist, change over time. In addition, we also explored whether student skills and capabilities have been impacted by COVID-19.

The results indicated no differences in student overall mean response between the COVID (total numbers =20) and Normal (total numbers =14) period; however, when we looked into subcategories, ETS students scored significantly lower in student optimism (P=.025), confidence (P=.011), coping self-efficacy (P=.034), and engineering career success expectation (P=.005) during the COVID

period than the Normal period. As a result, we plan to continue to utilize reflection as a high impact practice (HIP) in support of today's S-STEM students and for similar challenges in the future.

1. Introduction

A student's preparation and readiness to initiate and respond to changes in the constantly-changing environment is important for student success in their academic achievement and personal life satisfaction. Research has shown that the reflection high impact practice (HIP) is beneficial for students to develop self-authorship, resulting in shaping their "view of myself." Students find reflection helpful in envisioning their future development, citing conversations with faculty and peers as essential in helping them consider their career options and preparing them for success in academic and personal life [1, 2, & 3].

S-STEM financially supported students: ETS-IMPRESS (The Engineering Technology Scholars – IMProving REtention and Student Success) students participate in the Honors College Pathway Program, where they write reflections near-weekly to gain perspective of their experiences and reflect on how it can be used as a basis for future action. The benefits to students, as a whole are growth in their ability to craft reflections and in their feelings of inclusion leading to better student integration and professional skill success. Students in the "hands-on" fields of engineering technology see the benefits of reflection. Introducing regular reflection into their curricula can help their academic and professional development, and we all benefit from more thoughtful engineers.

This study focuses on previous research by Fiss et al. [1], reporting challenges critical for ETS-IMPRESS students: having lower ratings in their change-readiness level, such as optimism and adventurousness, and approaching a significantly lower rating in their feeling of inclusion in the subscale of self-efficacy, compared to other honors students participating in the same Honors Program.

As shown by Pokhrel and Chhetri [4], students' social skills and professional skill development in education systems have been disrupted by the COVID pandemic. Lacking hands-on, laboratory experiences may lessen students' self-efficacy [5] and student confidence in pursuing a career goal may be reduced by decreased confidence in self-efficacy and professional skill development [6]. Research from the same university as our ETS scholars' also indicated that "providing meaningful practical experiences was a critical concern for both faculty and students" and students commented on their hand-on experiences during COVID transition as from "unexpected" to "unsustainable" [7]. Therefore, with the implementation of reflection practice in the Honors Program, we would like to investigate whether the COVID-19 global pandemic may have had an impact on ETS students' professional skill development, such as their change-readiness, self-efficacy, and intent to persist.

Overall, this study aims at conducting a pretest/posttest and longitudinal study design to examine how student skill development outcomes, such as student self-efficacy, change-readiness, and intent to persist, change over time. For the pre- and post-tests, we compared ETS students' first survey responses when they started to participate in Honors Program with their latest responses in the Program. In addition, we also explored whether these skills and capabilities have been impacted by COVID-19. These measures serve as a tool to better understand the professional skill development of

ETS students in engineering technology hands-on disciplines who are academically talented and financially underserved.

2. Methodology

This study has undergone review and has been determined to be exempt by the university's Institutional Review Board (IRB).

2.1 Participants

Participants were ETS-IMPRESS student scholars who entered the program as first-year students or community college transfer students. The program was set up in 2018, aiming at increasing the number and diversity of students pursuing degrees in engineering technology who were first-generation, underrepresented students, women, and/or veterans. The program enrolled 10 students the first year and then 2 ~ 5 students per year since the COVID pandemic began.

There were 20 respondents (out of a total of 21 ETS-IMPRESS scholars) to three questionnaires (95.45% response rate). Among them, seventeen (94.44%) were males and three (100%) were females. Participants' majors included Electrical Engineering Technology, Computer Network & System Administration, Mechanical Engineering Technology, Cybersecurity, and Mechatronics.

Student (total N=20) responses collected before they started the Honors Program serve as pre-test data. Among them, 14 students have enrolled in the program seminars more than once and their last survey responses were used as post-tests. Regarding COVID and Normal time period comparison, 15 ETS students have completed the questionnaires at the Normal time period while 13 students have responded during the COVID time period. We define the COVID time period as when the university announced the start of the pandemic and enforced facial covering mandates (3/16/2020) and ended with the announcement of moving to Health and Safety Level One when facial coverings were no longer required on campus (2/25/2022). The Normal time period can be traced back to Fall 2018 when we started to administer surveys, excluding the COVID time period. That is to say, Normal period includes the period before COVID as well as after COVID.

2.2 Survey Structure

SurveyMonkey, an online survey development cloud-based software, was used to administer the questionnaires (Appendix A). The survey is comprised of three classic, validated questionnaires:

1) The Change-Readiness Assessment [8] evaluates participant readiness and confidence in preparation for a specific challenge in a changing environment. It is a 35-item scale with 7 categories, including adaptability, adventurousness, confidence, drive optimism, resourcefulness, and tolerance for ambiguity. This assessment is validated and has been employed in the areas, such as education [9], psychology and culture determinants [10], and human resource and job satisfaction [11].

2) The Longitudinal Assessment in Engineering Self-Efficacy (LAESE) [12] measures undergraduate engineering students' self-efficacy. It consists of 30 questions with 6 subscales

to address the aspects of career success expectations, engineering self-efficacy, coping self-efficacy, feeling of inclusion, and mathematics outcome expectations. LAESE is extensively researched in woman engineering students [12, 13], in levels of gender, ethnicity, years in college, and transfer status [14], and first-year engineering students [15].

3) Persistence Measures [16] uses 4 questions to measure 3 items, including career development, graduate study, and intent to change majors. This measure has been employed in the STEM fields [16], first-year woman engineering [17], gender identification and stereotypes [18], and science career aspirations [19].

These questionnaires all employed 7-point Likert scales, 1 referring to "not at all true of me" while 7 denoting "very true of me."

2.3 Design and Procedure

We managed data, performed quantitative data analysis, and visualized data, such as histograms and Likert Scale percentage plotting, using R programming language (version 1.3.959). We used Welch two-sample t tests in R to perform statistical analysis and analyze student response differences between pre- and post-tests in each of the surveying questions.

We utilized a within-subjects design where all ETS students enrolled in the Honors Program seminars were required to complete three classic, validated questionnaires (Appendix A) multiple times before they completed the Program. Students in the Honors Program complete the questionnaires at the beginning of the seminars and when they complete the last seminar. Only two surveying results were used to perform pre-tests (baseline) and post-tests (most recent follow-up): ETS-IMPRESS students' first-time, baseline responses to the questionnaires and their last-time, most recent follow-up responses. This is because we are interested in understanding student skill development change before and after reflection intervention, regardless of the fluctuation in between. The mean response is calculated from the sum of all the values divided by the total number of values in a subscale. We also compare ETS students' overall mean responses between COVID and Normal time periods and investigate whether COVID-19 has an impact on ETS students' change-readiness, self-efficacy, and intent to persist.

3. Results

3.1 Student Change-Readiness

3.1.1 Overall Results and Pre- & Post-Tests

ETS students' scores had non-significantly increased in areas of optimism, adventurousness, confidence, adaptability, drive, resourcefulness, and tolerance for ambiguity from their first time responses while enrolling in the Honors Program to their last time responses. There were no statistically significant differences between pre- and post-tests, according to Welch two-sample t tests. When looking into each item (Appendix A), no significant differences were found between any of the pre- and post-tests based on Welch two-sample t tests. In general, Students reported high means (scored 4 and above) in categories of drive and resourcefulness, while they reported low means (scored below 4) in optimism, adventurousness, confidence, adaptability, and tolerance for ambiguity in both pre- and post-tests (Figure 1). Among seven scales, tolerance for ambiguity had the lowest mean scores (M=3.23, SD=0.38); 75% and 64% of ETS students reported low means in pre- and post-tests, respectively (Figure 2).

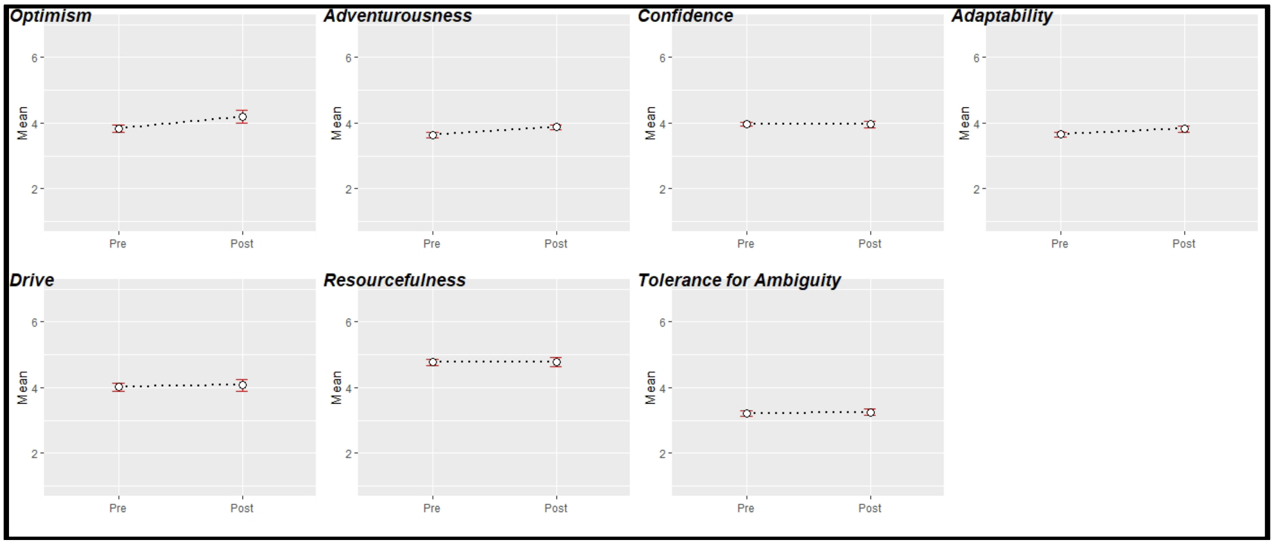

Figure 1: Pre- and post-test plots displaying ETS student change-readiness mean scores and error bars in the categories of optimism, adventurousness, confidence, adaptability, drive, resourcefulness, and tolerance for ambiguity.

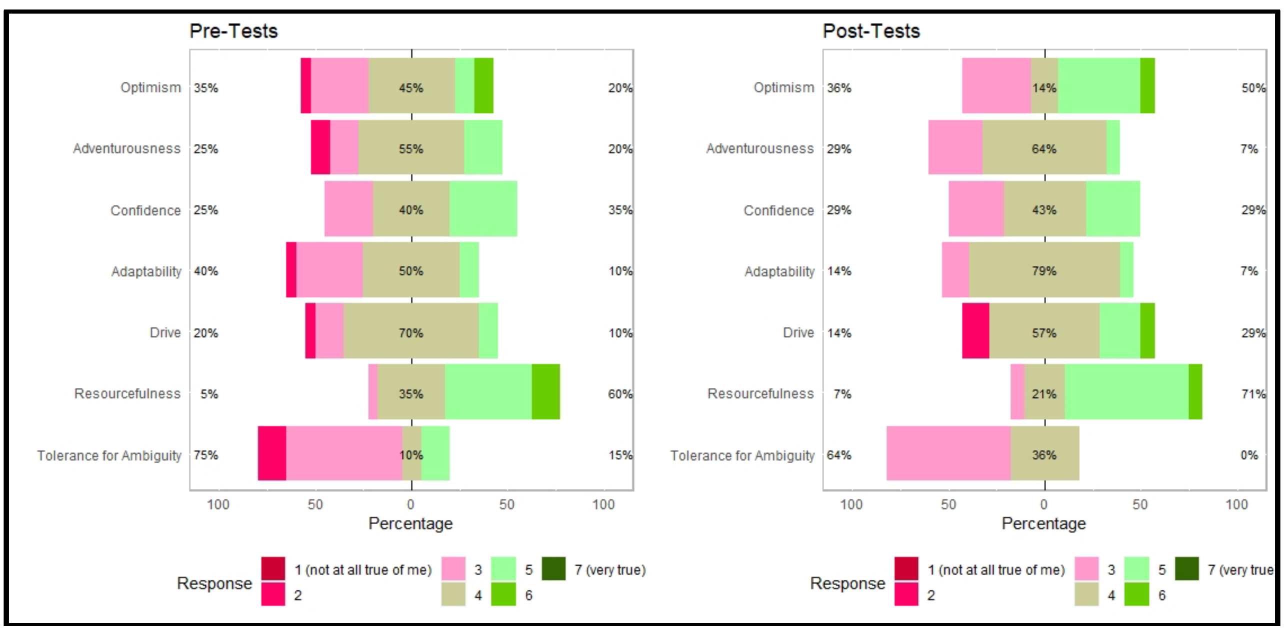

Figure 2: Frequency distributions of ETS student change-readiness overall results between pre-tests (left-panel) and post-tests (right-panel) in the categories of optimism, adventurousness, confidence, adaptability, drive, resourcefulness, and tolerance for ambiguity. The percentage of each response in each category is colored as seen in the bottom legend. The percentages of negative responses (i.e., 1, 2, & 3) are shown in the left side of the plots while positive responses (i.e., 5, 6, & 7) are presented in the right side of the plots. For example, the percentage comparison of “not at all true of me,” “rarely

true of me," and "sometimes but infrequently true of me" to "very true of me", "usually true of me', and "sometimes true of me" in Optimism of Pre-Tests are 35% and 20%, respectively.

3.1.2. Comparison between COVID and Normal Time Periods

There were no statistically significant differences between COVID and Normal time periods in any of the change-readiness categories. However, the results showed trends similar to pre- and post-test analysis: most of the students reported high means in the measures of resourcefulness in both COVID and Normal time periods, while they reported low means in optimism, adventurousness, confidence, adaptability, and tolerance for ambiguity in both periods (Figure 3).

In addition, the results also showed trends that about 25% more students regarded themselves as having low tolerance for ambiguity, while 18% more students thought themselves as having low confidence, 7% more students considered themselves as having low optimism, and 2% more students reported themselves as having low resourcefulness during the COVID time period, compared to the Normal period.

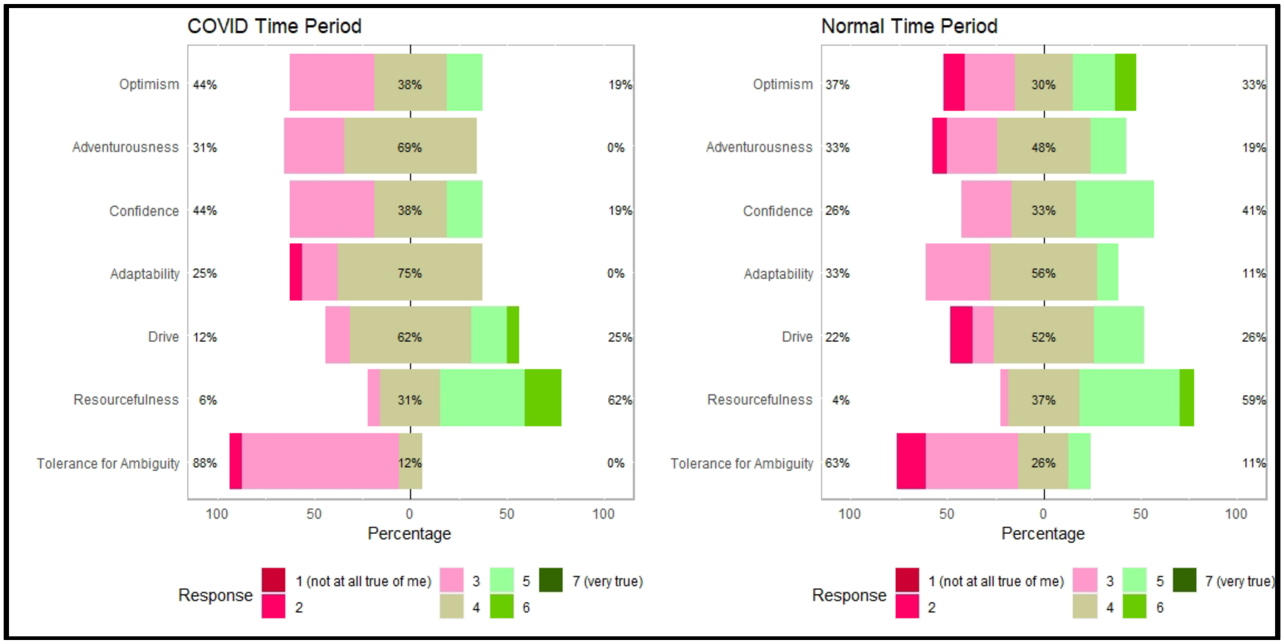

Figure 3: Frequency distributions of ETS student change-readiness overall results between COVID period (left-panel) and Normal period (right-panel) in the categories of optimism, adventurousness, confidence, adaptability, drive, resourcefulness, and tolerance for ambiguity. For example, the percentage comparison of "not at all true of me," "rarely true of me," and "sometimes but infrequently true of me" to "very true of me", "usually true of me', and "sometimes true of me" in the category of Tolerance for Ambiguity in COVID time period are 88% and 0%, respectively.

When further looking into each question item (total N=35) under seven categories, the results depicted that ETS students scored significantly lower in student optimism item 1 (*P*=0.025) and confidence item 3 (*P*=0.011) in the COVID period than the Normal period (Figure 4). Student responses reflected their perception of low optimism and low confidence during the COVID transition as seen in Table 1.

Table 1: Welch two-sample t tests in student optimism, confidence, and tolerance for ambiguity in the COVID and Normal time periods (selected).

Factor	Mean **(COVID)**	Mean **(Normal)**	95% CI Lower	95% CI Upper	t-test	df	p-value
Optimism: **I believe in not getting your hopes too high (reverse coded)**							
	2.63	3.37	-1.39	-0.10	-2.33	41	0.025
Confidence: **I can handle anything that comes along.**							
	4.06	4.81	-1.32	-0.18	2.66	41	0.011

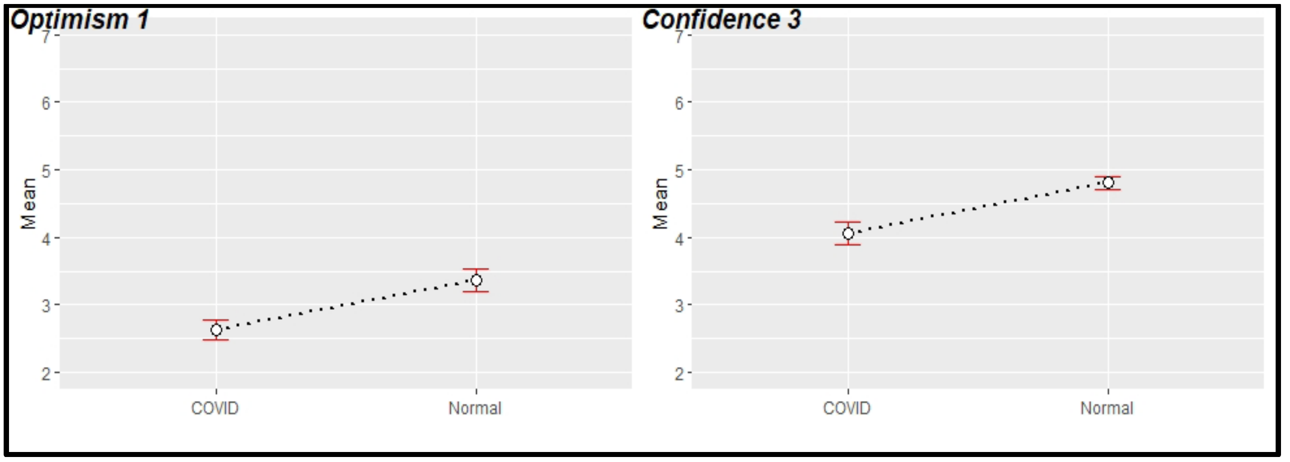

Figure 4: ETS student mean scores and error bars in the subcategories of optimism, Confidence, and tolerance for ambiguity.

3.2 Student Self-Efficacy

3.2.1 Overall Results and Pre- & Post-Tests

In general, ETS students reported overall high means (scored above 4) on both pre- and post-tests on the measures of feeling of inclusion, coping self-efficacy, engineering career success expectations, engineering self-efficacy I & II, and mathematics outcome expectations (Figure 5). Though, it depicted a trend that ETS students' scores had slightly decreased from pre- to post-tests in all categories, it does not reach significant differences based on Welch two-sample t tests. In addition, no significant differences have been found between pre- and post-tests in any of the self-efficacy items. Moreover, feelings of inclusion had the lowest mean scores (M=5.02, SD=1.15) among all self-efficacy scales (Figure 6).

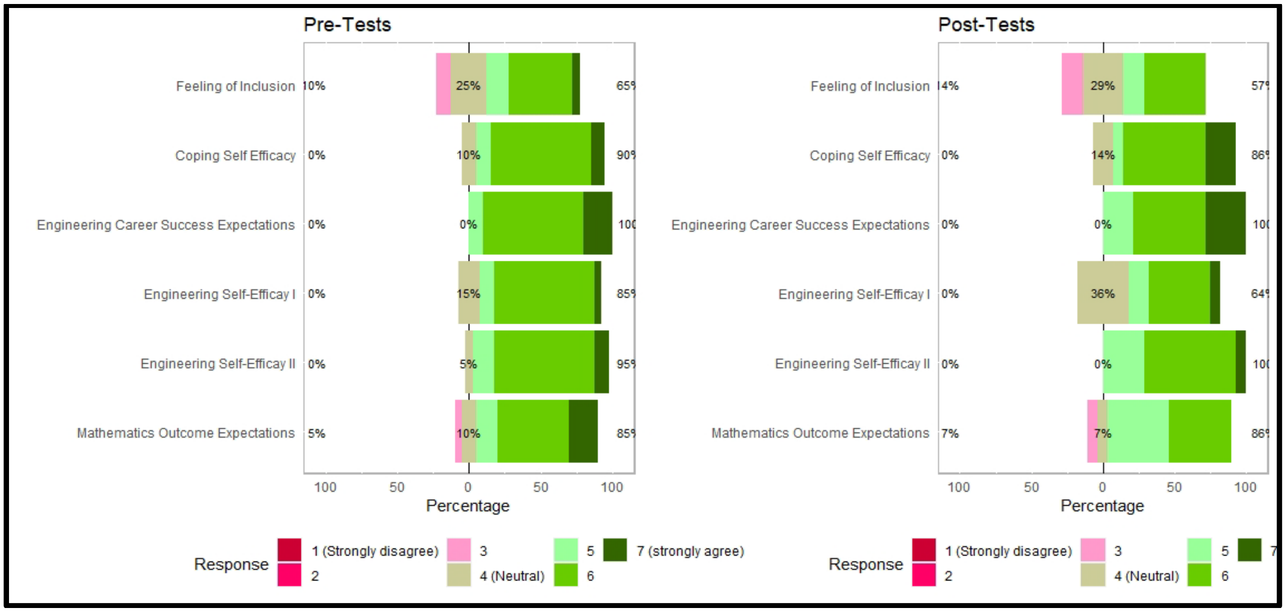

Figure 5: Frequency distributions of ETS student self-efficacy overall results between pre-tests (left-panel) and post-tests (right-panel) in the categories of feeling of inclusion, coping self-efficacy, engineering career success expectations, engineering self-efficacy I & II, and mathematics outcome expectations. For example, the percentage comparison of "strongly disagree," "disagree," and "somewhat disagree" to "strongly agree", "agree', and "somewhat agree" in Feeling of Inclusion in Pre-Tests are 10% and 65%, respectively.

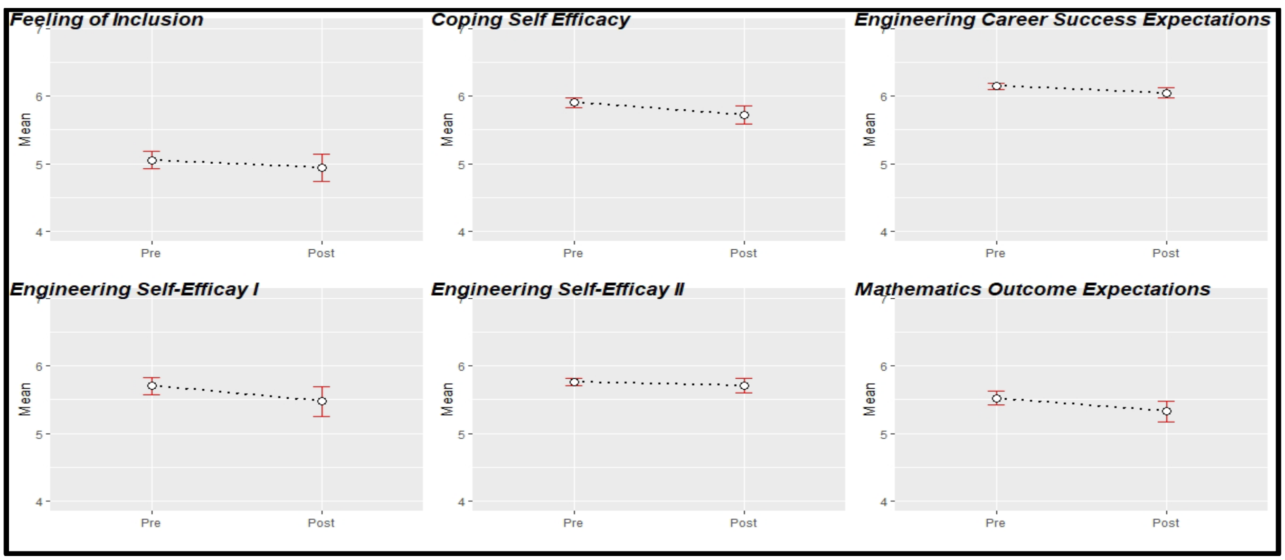

Figure 6: Pre- and post-test plots exhibiting ETS student self-efficacy mean scores and error bars in six subscales.

3.2.2. Student Self-Efficacy Comparison between COVID and Normal Time Periods

When further investigating student self-efficacy between COVID and Normal periods, it revealed that no significant differences were found in any of the categories. Students indicated high agreements on all categories in both COVID and Normal periods. In addition, the results also depicted patterns that about 15% more students considered themselves as having a high feeling of inclusion during the COVID time period, compared to the Normal period, revealing that COVID had no impact on student feeling of inclusion (Figure 7).

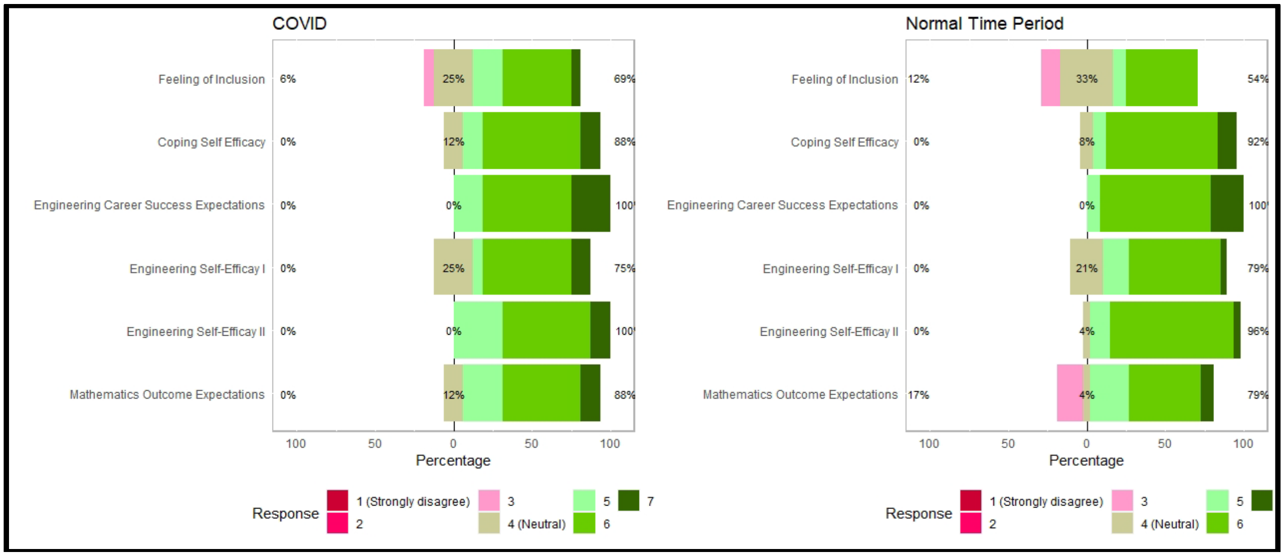

Figure 7: Frequency distributions of ETS student self-efficacy overall results between COVID (left-panel) and Normal (right-panel) time periods in six categories. For example, the percentage comparison of "strongly disagree," "disagree," and "somewhat disagree" to "strongly agree", "agree', and "somewhat agree" in Feeling of Inclusion in the COVID time period are 6% and 69%, respectively.

Furthermore, the results of the individual self-efficacy item (total N=28) showed that ETS students scored significantly lower in items under coping self-efficacy (P=0.0342), and engineering career success expectations (P_{ECSE1}=.0051 & P_{ECSE6}=0.0419) during the COVID time period than the Normal period (Figure 8). Student responses reflected their perception of decreased self-efficacy while attempting to get assistance from a faculty/staff and slightly decreased career expectation during the COVID period as shown in Table 2.

Table 2: Welch two-sample t tests in student self-efficacy in the COVID and Normal periods (selected).

Factor (Question Item)	Mean **(COVID)**	Mean **(Normal)**	95% CI Lower	95% CI Upper	t-test	df	p-value
Coping Self-Efficacy: **I can approach a faculty or staff member to get assistance with academic problems.**							
	5.63	6.21	-1.12	-0.05	-2.20	38	0.034
Engineering Career Success Expectation: **Someone like me can succeed in an engineering/technology career.**							
	6.13	6.65	-0.89	-0.17	-2.97	37	0.005

Engineering Career Success Expectation: **A degree in engineering/technology will allow me to get a job where I can use my talents and creativity.**							
	6.06	6.46	-0.78	-0.02	-2.11	38	0.042

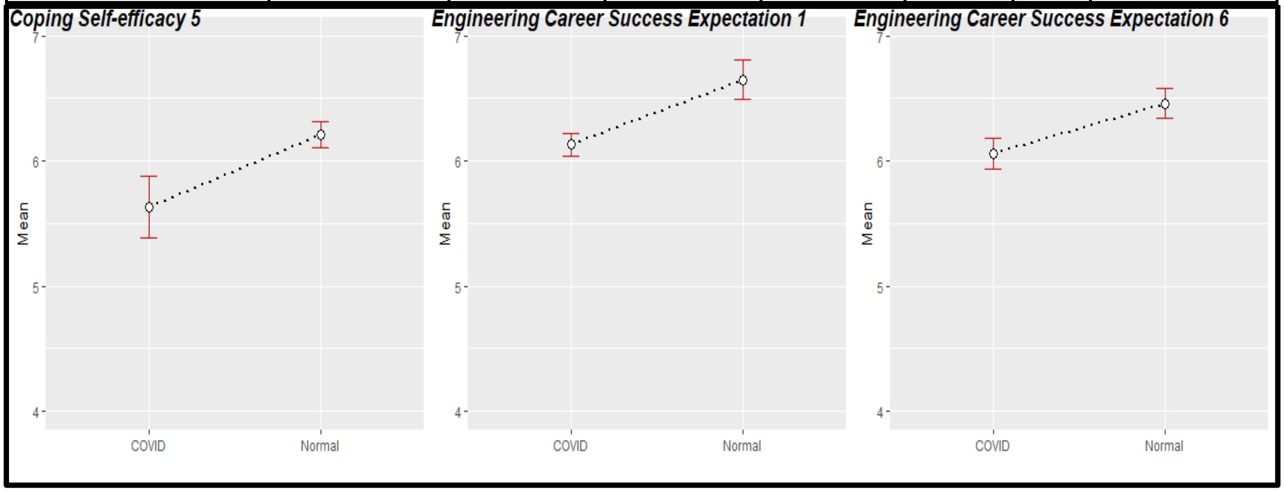

Figure 8: ETS student mean scores and error bars in the subscales of coping self-efficacy and engineering career success expectation.

3.3 Student Intents to Persist

3.3.1 Overall Results and Pre- & Post-Tests

In general, ETS students across pre- and post-tests showed similar trends in their intentions to persist. Students reported their intent on connecting their future career with their majors, they stayed consistent regarding pursuing graduate study, and they were less likely to change their major (Figure 9). Furthermore, it revealed that there were no significant differences between pre- and post-tests in the measures of career development, graduate study, and intent to change majors (Figure 10). Further investigating individual items (total N=5), no significant differences had been found in any of the subscales.

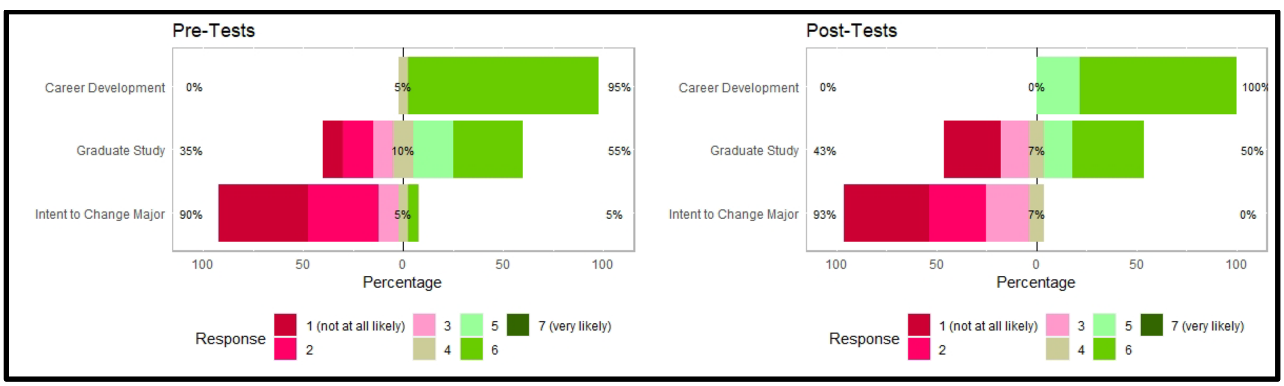

Figure 9: Frequency distributions of ETS student persistence overall results in pre-tests (left-panel) and post-tests (right-panel) time periods in three categories. For example, the percentage comparison

of “not at all likely,” “low likely,” and “slightly likely” to “very likely”, “likely’, and “moderately likely” in the category of Intent to Change Major in Pre-Tests are 90% and 5%, respectively.

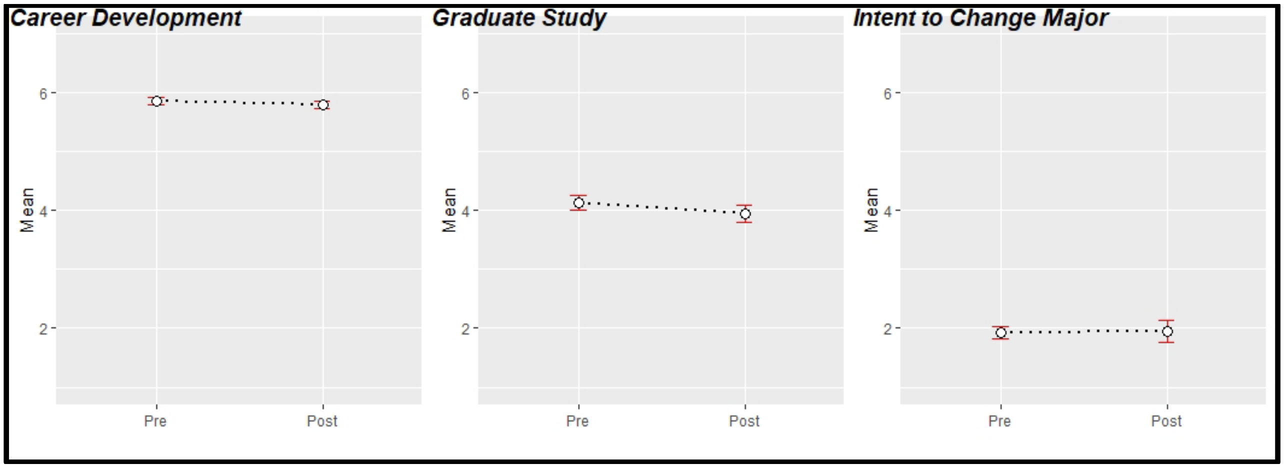

Figure 10: Pre- and post-test plots exhibiting ETS student persistence mean scores and error bars in the categories of career development, graduate study, and intent to change major.

3.3.2. Student Intents to Persist Comparison between COVID and Normal Time Periods

The results showed similar trends in both COVID and Normal periods in that ETS students had high intention to sustain their career development with their current majors, about half of the students were intent on pursuing graduate study, and they had low intention to change majors (Figure 11). There were no significant differences between COVID and Normal periods in three scales and individual items, indicating that ETS students’ career goals, graduate study, and majors remained steady across time as the pandemic unfolded.

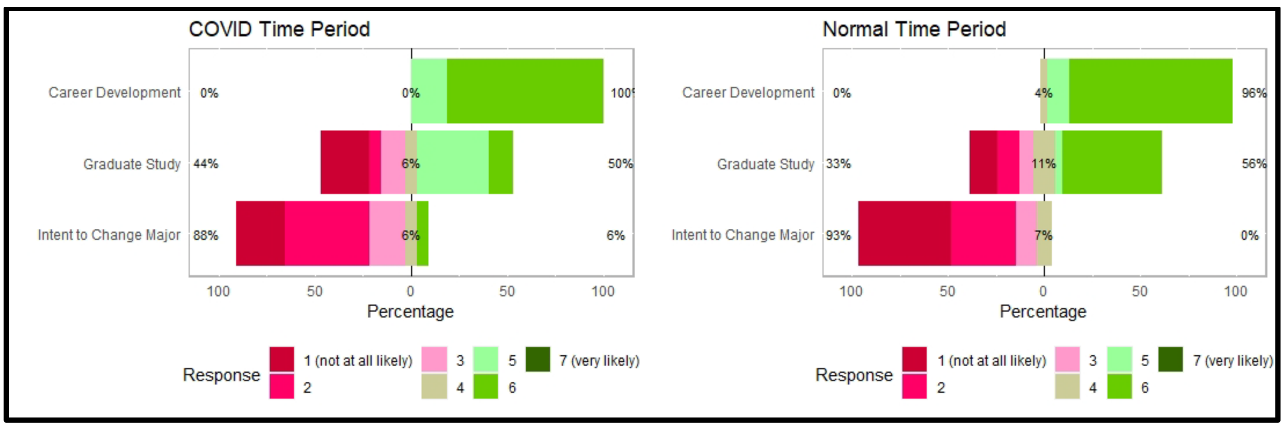

Figure 11: Frequency distributions of ETS student persistence overall results between COVID (left-panel) and Normal (right-panel) time periods in three categories. For example, the percentage comparison of “not at all likely,” “low likely,” and “slightly likely,” to “very likely”, “likely’, and “moderately likely” in the category of Intent to Change Major in the COVID time period are 88% and 6%, respectively.

4. Conclusion and Future Work

In general, the survey results showed no statistically significant differences in ETS student overall mean responses between first enrolling and exiting/last entry in in the Honors Program (pre- and post-tests) in any of the surveying areas. Note that 45% of the ETS students are transfers from community colleges, they only have two years in the ETS program, as compared to students being surveyed over four or more years from pre to post. Moreover, no significant differences between COVID and Normal periods were found, revealing that ETS students' career goals, professional skills and self-efficacy did not change across time during COVID. These findings can serve as evidence that immersing in reflection practice during the COVID pandemic may help students' professional skills stay consistent throughout their enrollment in Honors Program. Previous study at the same site revealed no statistically significant differences between ETS students and other honors students in the same Honors Program in overall means of motivation, intention to persist, professional skill development, and self-efficacy [1]. This also demonstrates that implementing reflection in the Honors Program is comparable to the same practice for ETS students.

A student's preparation and readiness to initiate and respond to changes in the changing environment, especially in facing an unprecedented challenge similar to COVID-19, is important for student success in their academic achievement and life satisfaction. When we further looked into subcategories, ETS students scored significantly lower in items such as student optimism (P=0.0246), confidence (P=0.011), coping self-efficacy (P=.034), and engineering career success expectations (P=.005 & 0.042) during the COVID period than the Normal period. These results revealed that ETS Student responses reflected their perception of the COVID transition. These include:

During the pandemic,

- students believe in not getting their hopes too high,
- it can be difficult for them to handle things as they come along,
- when they encounter academic problems, they may have some difficulty receiving faculty/staff assistance,
- students may harbor some doubts about their success in an engineering/technology career and using their talents and creativity to secure employment.

The limitations of this study are a small sample size and an unequal sample size in regards to gender, which may decrease the generalizability of the findings. In addition, participants were from a rural, mid-sized, science- and engineering-focused university, which may not be representative of students in an urban setting or at a larger more generally focused university. As for future work, we plan to expand this study to recruit students who are not involved in the reflection activities as a control group and compare their professional skill development and self-efficacy with ETS students.

As indicated above, for students who majored in engineering technology hands-on disciplines, hands-on issues are one of their primary concerns during the COVID pandemic [7]. Reflection practice for the financially supported, underrepresented S-STEM students not only increases student engagement and retention [1] and develops a "prototype of their future" [20], but it also provides a meaningful practical experience to students in engineering technology hands-on disciplines, especially when facing challenges throughout the COVID-19 pandemic. Based on the survey results, we can say that things did not get measurably worse during the COVID-19 pandemic. Previous research has suggested that self-efficacy is impactful to student choice of tasks and perseverance [21]. Therefore, we plan to continue to utilize reflection as a HIP for student self-efficacy enhancement and support of today's S-STEM students and for similar challenges in the future.

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Appendix A: Questionnaires Administered to ETS-Impress Scholars

1) Change-Readiness Assessment - Kriegel & Brandt, 1996			
Construct	No.	Items	Scales
a) Adventurousness	1	I prefer the familiar to the unknown. (REVERSED)	Likert Scale 1 (not at all true of me) to 7 (very true of me)
	8	I’m inclined to establish routines and stay with them. (REVERSED)	
	15	I prefer work that is familiar and within my comfort zone. (REVERSED)	
	22	It pays to stay with the tried and true. (REVERSED)	
	29	I prefer the main highway to the backroad. (REVERSED)	
b) Confidence	2	I rarely second guess myself.	
	9	I can make any situation work for me.	
	16	I can handle anything that comes along.	
	23	I focus on my strengths, not my weaknesses.	

	30	My faith in my abilities is unshakable.	
c) Adaptability	3	I'm unlikely to change plans once they're set. (REVERSED)	
	10	When something important doesn't work out, it takes me time to adjust. (REVERSED)	
	17	Once I've made up my mind, I don't easily change it. (REVERSED)	
	24	I find it hard to give on something even if it's not working out. (REVERSED)	
	31	When in Rome, do as the Romans do. (REVERSED)	
d) Drive	4	I can't wait for the day to get started.	
	11	I have a hard time relaxing and doing nothing.	
	18	I push myself to the max.	
	25	I'm restless and full of energy.	
	32	I'm a vigorous and passionate person.	
e) Optimism	5	I believe in not getting your hopes too high. (REVERSED)	
	12	If something can go wrong, it usually does. (REVERSED)	
	19	My tendency is to focus on what can go wrong. (REVERSED)	
	26	Things rarely work out the way you want them to. (REVERSED)	
	33	I'm more likely to see problems than opportunities. (REVERSED)	
f) Resourcefulness	6	If something's broken, I'll find a way to fix it.	
	13	When I get stuck I'm inclined to improvise solutions.	
	20	When people need solutions to problems, they call on me.	
	27	My strength is to find ways around obstacles.	
	34	I look in unusual places to find solutions.	
g) Tolerance for Ambiguity	7	I get impatient when there are not clear answers. (REVERSED)	
	14	I get frustrated when I can't get a grip on something. (REVERSED)	

	21	When an issue is unclear, my impulse is to clarify it right away. (REVERSED)	
	28	I can't stand to leave things unfinished. (REVERSED)	
	35	I don't perform well when there are vague expectations and goals. (REVERSED)	

2) The Longitudinal Assessment in Engineering Self-Efficacy (LAESE) – Marra & Bogue, 2006)

Construct	No.	Items	Scales
a) Engineering Self-Efficacy I	2	I can succeed in an engineering/technology curriculum.	Likert scale 1 (strongly disagree) to 7 (strongly agree)
	6	I can succeed in an engineering/technology curriculum while not having to give up participation in my outside interests (e.g. extracurricular activities, family, & sports).	
b) Engineering Self-Efficacy II	8	I can complete the math requirements for most engineering/technology majors.	
	11	I can excel in an engineering/technology major during the current academic year.	
	13	I can complete any engineering/technology degree at this institution.	
	19	I can complete the physics requirements for most engineering/technology majors.	
	24	I can persist in an engineering/technology major during the next year.	
	28	I can complete the chemistry requirements for most engineering/technology majors.	
c) Engineering Career Success Expectations	4	Someone like me can succeed in an engineering/technology career.	
	10	A degree in engineering/technology will allow me to obtain a well-paying job.	
	12	I will be treated fairly on the job. That is, I expect to be given the same opportunities for pay raises and promotions as my fellow workers if I enter engineering/technology.	
	15	A degree in engineering/technology will give me the kind of lifestyle I want.	
	18	I will feel "part of the group" on my job if I enter engineering/technology.	

	22	A degree in engineering/technology will allow me to get a job where I can use my talents and creativity.	
	27	A degree in engineering/technology will allow me to obtain a job that I like.	
d) Feeling of Inclusion	1	I can relate to the people around me in my classes	
	3	I have a lot in common with the other students in my classes.	
	5	The other students in my classes share my personal interests.	
	7	I can relate to the people around me in my extracurricular activities.	
e) Coping Self-Efficacy	14	I can cope with not doing well on a test.	
	16	I can make friends with people from different backgrounds and/or values.	
	21	I can cope with friends' disapproval of my chosen major.	
	23	I can cope with being the only person of my race/ethnicity in my class.	
	25	I can approach a faculty or staff member to get assistance with academic problems.	
	26	I can adjust to a new campus environment.	
f) Mathematics Outcome Expectations	9	Doing well at math will enhance my career/job opportunities.	
	17	Doing well at math will increase my sense of self-worth.	
	20	Taking math courses will help me to keep my career options open.	

3) Persistence Measures - Schmader, Johns & Barquissau, 2004			
Construct	No.	Items	Scales
a) Graduate Study	36	How likely is it that you will pursue graduate study related to your major?	Likert Scale 1 (Not at all likely) to 7 (Very likely)
b) Career	37	How likely is it that your eventual career after graduation will directly pertain to mathematics or science?	

c) Intent to Change Major	38	How often do you think about changing your major?	Likert Scale 1 (Not at all) to 7 (Very Often)
	39	How likely is it that you will change your major	Likert Scale 1 (Not at all likely) to 7 (Very likely)

Biographies

SARAH (YIN YIN) TAN is a Research Assistant Professor in the Engineering Fundamentals at Michigan Technological University. She received a MBA degree and a Ph.D. degree in Applied Cognitive Sciences and Human factors Program both from Michigan Tech. Her research program involves using complementary methods (e.g., statistical modeling and analytics, psychological assessment) to evaluate how individual differences are important and impact behaviors at a cultural, social, and behavioral level. She has served as a project evaluator in the multiple NSF funded projects.

JOHN L. IRWIN is a Professor for Mechanical Engineering Technology at Michigan Technological University, Dr. Irwin teaches courses in Product Design & Development, Statics and Strength of Materials, Parametric Modeling, and Senior Design. Research interests include STEM education, where as PI for Improving Teacher Quality grants (2010 & 2013) he has developed and implemented professional development courses for K-12 science teachers to implement inquiry-based learning while utilizing computer simulations and 3D printing in their classrooms to help solve engineering problems.