WHAT MAKES AN ENGINEER? STATISTICAL ANALYSIS OF FACTORS CONTRIBUTING TO ENGINEERING DISPOSITION

by

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ABSTRACT

Being able to determine which qualities and experiences lead students to be more inclined to identify as an engineer, maker, or designer can help to further understand retention rates among engineering students. We have investigated factors that may influence engineering and engineering technology students' professional disposition towards engineering, designing, and making. The factors considered include metacognitive awareness skills, prior making experiences, student demographics, and engineering design self-efficacy, which examines students' self-efficacy through four lenses: motivation, confidence, anxiety, and expectation of success. This thesis used data collected from a survey instrument conducted as part of courses incorporating makerspace-based projects over two years. The data was then filtered to analyze only the engineering and engineering technology students' initial responses which resulted in a sample size of 94 Texas State students. The dataset was analyzed to explore the following research questions: To what extent are students engineering design self-efficacy, metacognitive awareness, and/or prior making experiences correlated with their professional dispositions to be an engineer, designer, or maker? To what extent do students' demographics influence these correlations? As the data was not normally distributed, it was analyzed with nonparametric statistics. Key results indicated a moderate positive correlation trend among all three professional dispositions (maker, designer, engineer) with previous experience with tools. This trend indicates that students

who have more previous experience with makerspace tools are more likely to self-identify as one or more of these dispositions. Further, the maker and designer professional dispositions both had a moderately positive correlation trend with student's self-efficacy measures of confidence and motivation to conduct engineering design. This trend indicates that students with stronger dispositions to identify as makers and designers had higher confidence and motivation to conduct engineering design. When examining the intersection of factors, it was found that the strongest correlations between metacognitive awareness and engineering design self-efficacy were between the students' motivation to conduct engineering design and their tendency to use procedural knowledge, conditional knowledge, information management, and debugging strategies in their learning styles. When comparing between student demographic groups, there were few statistically significant differences. The notable trend was by gender and students' engineering design self-efficacy. Male students reported significantly higher engineering design self-efficacy scores through the lenses of their motivation and their confidence. Overall, these findings indicate students with more prior making experiences as well as higher levels of engineering design self-efficacy tend to be more likely to have an engineering, designing, and/or making disposition.

I. Introduction

The US workforce has a growing need for people to work in STEM fields, but the supply of students is not able to meet this demand (Kuley 2015). One way to address the workforce shortfall is to retain more students who are interested in studying engineering and engineering technology. In this effort education research has been investigating why students persist in or leave their major course of study for years. This research has shown a variety of factors to influence retention such as self-efficacy, professional identity formation, and belonging (Kuley 2015). Being able to better understand how these students perform and gain qualities such as confidence and motivation, can lead to a more in depth understanding of their professional disposition. Regarding identity development the factors currently being investigated into are multifaceted and have yet to be generalized.

Engineering identity is relatively a new field of study, exploring this topic will ultimately lead to a better understanding of how and why students persist in engineering majors as well as the engineering profession. Further, there has been a growing trend to offer academic makerspaces on engineering campuses as a way to foster the development of engineering students. Makerspaces, however, have been little studied – especially in the intersection of students' disposition to be makers and/or engineers. This thesis explores this interplay between and influences upon students' maker, engineering, and design dispositions. The factors under consideration include metacognitive awareness, engineering design self-efficacy, prior maker-space related experiences, as well as demographics. This information was collected through the use of a survey in a university wide makerspace, upon students first use of the space over a two-year period.

II. Literature Review

This section describes current research on student's retention. As well as the other elements such a MAI and prior experiences that may be tied to retention. These factors will be further examined in the following research.

Retention and Climate

Kuley explains the ongoing need for retention to be a priority of university programs nationwide due to the constant demand and pressure from society to have engineering students that can meet the industry's demands (Kuley 2015). Kuley further explains that retention in past research is dependent on numerous factors, including the institutional climate. Intuitional climate can be defined as how welcome the program and university make a student feel as well as the resources available for students. Students' satisfaction, especially when discussing first generation, underrepresented groups, and females in the engineering field, is heavily dependent on this institutional climate. Research suggests students who stay in the engineering field overall are more motivated and successful students dependent on their environment (Kuley 2015). Allen et al's (2008) study address the problem of low graduation rates and how they relate to persistence towards finishing a degree. These findings indicated social connectedness and motivation had significant effects on whether students stayed in their degree path. Motivation is a factor that was considered in our study as well when looking at engineering student's retention. Beck et al. (2014) involved studying different factors and their influence on retention rates specifically for Native American students. This study found that both white and Native American students had significant interactions when the factor of social enrichment was correlated with positive GPA results. This finding

indicates when students have access to more social opportunities that make it easier to be involved in campus life and are more socially outgoing in their intuition it can cause a positive outlook and create an additional support system for students (Beck 2014). Overall, these sources indicate there are several factors in universities that play a part in students retention rates as well as factors increasing students outlook on their own abilities. These sources prove to be relevant and showcase the importance of researching how to keep students following their degree path.

Self-Efficacy

Self-efficacy has been defined as "an individual's judgment of their capability to organize and execute courses of action for a given task" (Bandura, 1986). To excel in challenging tasks such as difficult courses as a student one must believe in their own abilities to even try or put forth a valuable effort. The higher their self-efficacy the more a student will use strategies such as cognitive and metacognitive skills. These strategies can result in individuals who can accomplish more difficult tasks and be more willing to attempt such tasks (Tsenn, McAdams, Linsey 2013). Carberry conducted research discussing self-efficacy with engineering design back in 2010, the results from that study suggested the following, that students engineering design self-efficacy showed to be very dependent on previous experiences with engineering concepts (Carberry 2010).

Higher self-efficacy leads to higher achievement which indicates how important of a variable this is in our research to be studied. Like our study the research conducted by Tsenn, McAdams, and Linsey took engineering design scores such as motivation, success, and anxiety to examine how these lenses relate to design activities (Tsenn,

McAdams, Linsey 2013). The results of their study concluded that self-efficacy was built up through past engineering experiences but the use of additional course work to be more prepared for design concepts did not help with task-specific self- concept scores as they had hoped.

University Makerspaces

An interesting concept is asking how can we in the university setting cultivate self-efficacy among students? This may present as a challenging problem due to limited resources but a solution that may promise great success is university makerspaces, University makerspaces can be defined as "a place in which people with shared interest... can gather to work on projects while sharing ideas, equipment, and knowledge." (Oxford Languages). Research conducted by Mr. Morocz in 2015 hypothesized that the creation of maker space environments could potentially offer a place to cultivate creativity in a university setting. The objectives of this research focused on assessing the impact of maker spaces as well as researching approaches of effective university makerspaces (Morocz 2015).

Professional identity

Engineering identity can be dependent on numerous variables such as gender, race, and experience (Carberry, Lee 2010). Note that self-concept can influence how an individual learns and tends to be overlooked when assessing student learning in engineering. Students feeling a sense of belonging to the engineering community is crucial to the success of the student (Meyers, Ohland, Pawley, Silliman, Smith, 2012).

Gerber, Olson, and Komarek (2012) state that self-efficacy not only supports innovation, but it also supports academic motivation, retention, learning, and achievement. By fostering these skills in the classroom that show correlation with engineering identity can lead students to be more well prepared for the world (Gerber,Olson,Komarek 2012).

MAI

Schraw and Dennison (1994) defined metacognition as the ability to reflect upon and control one's learning. Metacognition essentially is an individual's ability to manage their cognitive skills. Metacognition goes hand in hand with success in the classroom, as it helps an individual be self-aware of their skills. This self-awareness can lead to the ability to manage and correct and learn from mistakes.

Metacognition is broken down into three subprocess of self-reflection: declarative knowledge is knowledge about self and strategies; procedural knowledge is knowledge about how to use said strategies; and conditional knowledge is knowledge about when and why to use strategies (Schraw, Dennison 1994). There are an additional five attributes beyond the three subprocesses of metacognition: planning, information management strategies, comprehension, debugging strategies, and evaluation. Individuals that score higher in the metacognitive categories tend to outperform their competition. In result these metacognition skills can lead to students having more success at learning and using strategies to enhance themselves. Schraw and Dennison (1994) further explain that an issue that is prevalent is the ability to identify metacognitively aware learners. The data that has been collected from students regarding the metacognition section will be analyzed and looked at for significance in a student's

ability for retention. This information proves to be vital in the classroom, teaching students in a way that will active this type of metacognitive learning ultimately can lead to better retention in students.

Prior experiences

Gerber, Olson, and Komarek (2012) touch on how students need practice and opportunities in order to be innovative but many schools, especially in higher education, lack these opportunities for students. Students who lack in areas such as motivation and confidence are even less likely to attempt in areas of innovation (Gerber 2012). Our society heavily relies on innovation especially in the STEM field. With increasing demand in fields such as engineering and engineering technology it is important that students have access to environments such as hands on experience to build their confidence and identity. Gerber's research conducted showed that students with hands on experiences had successful completion of innovation self-efficacy (Gerber 2012). Previous research conducted by Mr. Mohamed Galaledin and Dr. Hannan Anis (2019) points out how impactful fostering a maker mindset which is described as "curious, playful, optimistic, persistent…" and how similar those qualities are to an engineering mind. Their research focused on the integration of making activities into project-based-learning engineering courses. Their results showed a significant association between students who took an engineering design course that had integrated making activities were more likely to be identified has having a making mindset in comparison to students who took the traditional course.

Summary

These sources give grounds to why this research is important. The factors discussed are all equally important in our statical analysis. These sources help to further prove the variables chose for the survey instrument have significant relevance to the topic at hand as well as further expand as the reason why they were chosen. Prior experiences, metacognition strategies, and self-efficacy all have the potential to be statistically relevant when looking at retention and professional disposition.

III. Procedure

Survey

As a part of a study on the formation of a maker identity faculty were recruited to incorporate a makerspace-based project in their courses. Students in these courses were invited to participate in this study by taking surveys at the beginning and end of the semester with the makerspace project. This paper examines the pre-semester responses of engineering and engineering technology students to examine pre-existing trends with respect to engineering, making, and design dispositions.

The survey had 50 items, dependent on the section students had various scales to answer by. The survey was administered using an online survey tool (Survey Monkey). The survey on average took students twenty minutes to complete. The survey consisted of multiple items, including the MAI, prior experiences with making, EDSE scores, which dealt with students' confidence, motivation, success, and anxiety to conduct engineering design and student's demographics. In the beginning 55 of the students' responses were deleted due to not consenting, 260 responses were deleted due to incomplete data, and 297 responses deleted due to duplicate user rows, in total the survey had 818 viable responses with 94 of them being engineering or engineering technology students. Those 94 responses were used for the analysis.

The first section of this survey presented the EDSE instrument. This instrument asks the students to evaluate their current abilities to conduct engineering design. This consisted of the same nine prompts repeated into four aspects of their abilities: their

expectation of confidence, motivation, success, and anxiety. In each of these sections students were asked to rate their belief in their current ability to perform the nine tasks. Students were able to input scores that ranged from 0 to 100. Students were given the scale as follows, 0= cannot do at all, 50= moderately can do, 100= highly certain can do. These answers were recorded and then further broken down into average scores for analysis. An example of one of the prompts that was included in each EDSE section is as follows "rate your degree of confidence (i.e. belief in your current ability) to conduct engineering design."

The next section students filled out was the MAI section, this consisted of 52 questions where students could choose the following responses dependent on their questions, very untrue of me, untrue of me, neutral, true of me, and very true of me. This sections question was broken down into 8 different subcategories as follows, procedural knowledge, declarative knowledge, conditional knowledge, information management, debugging strategies, planning, comprehension monitoring, and evaluation. These 52 questions and subcategories are from a past study conducted by Schraw and Dennison in 1994 entitled, Assessing Metacognitive Awareness. The student's responses were then scaled to a numeric value, very untrue of me = 0, untrue of me= 1, neutral = 2, true of me = 3, and very true of me = 4. Once this data was scaled, I used this to create the value for the eight subcategories previously mentioned. To better understand these eight categories Schraw and Dennison defined them as follows in their personal research. Declarative knowledge deals with facts, critical thinking skills, and the ability to learn through presentations. Procedural knowledge is knowing how to complete procedures based off learning such as problem solving. Procedural knowledge is used when a student is aware

of the process and is able to know when to apply. Conditional Knowledge regards being able to determine when and why to use learning procedures. Conditional knowledge uses both declarative and procedural knowledge when applied. Next is Planning, planning deals with setting goals and planning ahead of time to set aside resources and time. Information management strategies is using strategies to better retain information some common strategies include summarizing and organizing information. Comprehension monitoring is best described as an assessment of an individual's learning. Debugging strategies are in place when one is able to comprehend that a correction is needed whether that's in performance or cognitively. The final category being evaluation, evaluation is an individual's ability to analyze their performance afterwards (Schraw, Dennison 1994). This breakdown of metacognition regarding the 52 questions and 8 categories included on the survey was pulled from Schraw and Dennison's study in 1994.

The next section students were asked to fill out was the prior experiences section. This section included three subcategories with in it. Within each section students were given prompts of experiences they may have had and if it was applicable to them, we asked the students to check off that experience as previously done. The first being individual experience with tools, the prompts given for this section are as follows, 2D cutting, 3D printing, CNC, embroidery, sewing, and soldering. The next category was entitled making activities, the prompts given are as follows, art, crafting, construction, cooking, leather work, scrap booking, sculpting, welding, and wood working. The final section was making mindset, this section included the following prompts, taking stuff apart to see how it works, and tinkering. The students were given an option to write in

other responses if needed. These responses were recorded and then placed in the most appropriate subcategory of the three mentioned. These making activity prompts were created by the group, based off typical experiences from a broad range of high schools as well as current resources available by the makerspace team.

Students were also asked if they identified as a maker, designer, and or engineer. Students were given the following responses to choose from, Yes, In some ways yes and some ways no, and no.

From this data stems our research questions.

1. How correlated are students engineering design self-efficacy and engineering professional identity?
2. How correlated are students engineering design self-efficacy and professional design identity?
3. How correlated are students engineering design self-efficacy and making identity?
4. What interconnection lies between students' professional identities, EDSE, and MAI?
5. How correlated are students engineering design self-efficacy and MAI scores?
6. How correlated are students' professional identities such as engineering, designing, and making with their MAI scores?

After collecting and reviewing the results the data from these survey responses was organized as the following.

Data	Type
EDSE	Ratio or Interval (continuous)
MAI	Ordinal
Professional Identity	Ordinal
Demographics	Nominal with some being Binary

The first tests used to analyze our data were tests of association which included spearman's rho and Kendall Tau. Kendall Tau was used to grasp an understanding of the strength of the relationship between various variables. The variables that were tested using Kendall tau could either be ordinal or continuous. Ordinal data is data that have an inherent order for example the education level of the students. Continuous indicates the variable can have any reasonable value such as age. Very similar to Kendall Tau, Spearman's Rho is another test of association that measures the strength of association between two variables. With both test outputs I was able to analyze the correlation coefficients as well as the n value. Significant p values were data that is less than or equal to .05 and were flagged on the data sheet. (Statistics Solutions 2021)

Ordinal logistic regression was also used to analyze the data. Ordinal logistic regression is used to predict a single ordered categorical variable with the use of one or multiple variables. This test also has the potential to be used to predict the numerical relationship between variables. This test was issued to grasp a better understanding of the relationship between these variables as well as in prediction of another. (Statistics Solutions 2021)

The next test used was a Mann-Whitney U test. The Mann-Whitney U test is issued to see if two groups of data are significantly different on the variable of interest. The two groups used are independent and the variable of interest must be continuous. The Mann Whitney U test outputted mean rank data that was analyzed based upon the various grouping variables. (Statistics Solutions 2021)

Null Hypothesis Table

From this data results in the hypothesis tables:

1. How correlated are students engineering design self-efficacy and engineering professional identity?

Hypothesis	Test
Ho: There will be no significance between students EDSE Confidence score and engineering identity disposition H1: There will be a significant correlation between students EDSE confidence score and engineering identity disposition	Spearman Rho Kendall Tau Mann Whitney U
Ho: There will be no significance between students EDSE motivation score and engineering identity disposition H1: There will be a significant correlation between students EDSE motivation score and engineering identity disposition	Spearman Rho Kendall Tau Mann Whitney U
Ho: There will be no significance between students EDSE successful score and engineering identity disposition H1: There will be a significant correlation between students EDSE successful score and engineering identity disposition	Spearman Rho Kendall Tau Mann Whitney U
Ho: There will be no significance between students EDSE anxiety score and engineering identity disposition H1: There will be a significant correlation between students EDSE anxiety score and engineering identity disposition	Spearman Rho Kendall Tau Mann Whitney U

2. How correlated are students engineering design self-efficacy and professional design identity?

Hypothesis	Test
Ho: There will be no significance between students EDSE Confidence score and designer identity disposition H1: There will be a significant correlation between students EDSE confidence score and designer identity disposition	Spearman Rho Kendall Tau Mann Whitney U
Ho: There will be no significance between students EDSE motivation score and designer identity disposition H1: There will be a significant correlation between students EDSE motivation score and designer identity disposition	Spearman Rho Kendall Tau Mann Whitney U
Ho: There will be no significance between students EDSE successful score and designer identity disposition H1: There will be a significant correlation between students EDSE successful score and designer identity disposition	Spearman Rho Kendall Tau Mann Whitney U
Ho: There will be no significance between students EDSE anxiety score and designer identity disposition H1: There will be a significant correlation between students EDSE anxiety score and designer identity disposition	Spearman Rho Kendall Tau Mann Whitney U

3.How correlated are students engineering design self-efficacy and making identity?

Hypothesis	Test
Ho: There will be no significance between students EDSE Confidence score and maker identity disposition H1: There will be a significant correlation between students EDSE confidence score and maker identity disposition	Spearman Rho Kendall Tau Mann Whitney U
Ho: There will be no significance between students EDSE motivation score and maker identity disposition H1: There will be a significant correlation between students EDSE motivation score and maker identity disposition	Spearman Rho Kendall Tau Mann Whitney U
Ho: There will be no significance between students EDSE successful score and maker identity disposition H1: There will be a significant correlation between students EDSE successful score and maker identity disposition	Spearman Rho Kendall Tau Mann Whitney U
Ho: There will be no significance between students EDSE anxiety score and maker identity disposition H1: There will be a significant correlation between students EDSE anxiety score and maker identity disposition	Spearman Rho Kendall Tau Mann Whitney U

4. What interconnection lies between students' professional identities, EDSE, and MAI?

Hypothesis	Test
Ho: There will be no significant correlation between student's professional identities, EDSE scores, and MAI. H1: There will be significant correlation between students' professional identities, EDSE scores, and MAI.	Spearman Rho Kendall Tau Mann Whitney U

5. How correlated are students engineering design self-efficacy and MAI scores?

Hypothesis	Test
Ho: There will be no significant correlation between students EDSE scores and MAI scores. H1: There will be significant correlation between students EDSE scores and MAI scores.	Spearman Rho Kendall Tau Mann Whitney U

6. How correlated are students' professional identities such as engineering, designing, and making with their MAI scores?

Hypothesis	Test
Ho: There will be no significant correlation between student's professional identity dispositions and their MAI scores. H1: There will be significant correlation between student's professional identity dispositions and their MAI scores.	Spearman Rho Kendall Tau Mann Whitney U

IV. Outputs

Table 1) Descriptive Statistics

	Mean	Median	std. Deviation
EDP Confidence	65.46	70.62	23.98
EDP Motivated	78.51	83.12	21.41
EDP Successful	68.28	74.37	24.08
EDP Anxiety	47.61	50	27.72
Procedural knowledge	11.84	12	1.93
Declarative Knowledge	23.46	24	3.96
Conditional Knowledge	15.17	15	2.46
Information Management	28.54	29	4.82
Debugging Strategies	14.91	15	2.61
Planning	18.91	19	3.95
Comprehension Monitoring	19.48	20	4.19
Evaluation	16.15	17	3.51
individual Experience with tools	2.23	2	1.46
Making Activities	4.48	4	2.01
Making mindset	1.14	1	0.77
Do you consider yourself to be a maker?	1.18	1	0.76
Do you consider yourself to be a designer?	1.08	1	0.74
Do you consider yourself to be an Engineer?	1.37	2	0.74

Table 2) Normality Test that includes variance, skewness, and standard error of skewness

	Skewness	Kurtosis
EDP Confidence	-0.954	0.569
EDP Motivated	-1.453	2.465
EDP Successful	-1.443	1.826
EDP Anxiety	0.056	-0.963
Procedural knowledge	-0.447	1.192
Declarative Knowledge	-0.202	0.575
Conditional Knowledge	-0.466	0.423
Information Management	0.01	-0.371
Debugging Strategies	-0.28	-0.14
Planning	0.057	0.201
Comprehension Monitoring	-0.26	-0.114
Evaluation	-0.188	-0.154
Individual Experience with tools	0.363	-0.616
Making Activities	0.06	-0.656
Making mindset	-0.244	-1.268
Do you consider yourself to be a maker?	-0.314	-1.236
Do you consider yourself to be a designer?	-0.13	-1.175
Do you consider yourself to be an Engineer?	-0.729	-0.815

Table 3) Kendall Tau and Spearman Rho for professional identity and EDSE scores

Table 3 shows the four lenses of EDSE scores (confidence, motivation, expectation of success, and anxiety) tested with Kendall Tau and Spearman Rho to explore to what extent to these EDSE scores correlate with the three professional dispositions (Maker, Designer, and Engineer). In this comparison, students Maker Disposition is significantly positively correlated with their Confidence, Motivation, and Expectation of Success in conducting engineering design, although with a moderate strength of association. Design disposition also had a significant positive correlation with student's confidence and motivation to conduct engineering design, with motivation having a moderate strength of association with Designer disposition and confidence having a low strength of association. Engineering disposition, however, only had significant correlations at the 90% confidence level with any EDSE score. It was positively correlated with student's confidence and expectation of success in conducting engineering design, although with low strength of association.

		Maker	**Designer**	**Engineer**
	EDSE- Confidence			
Kendall Tau	τ_b	**0.28**	**0.23**	*0.16*
	p	.001	.008	.074
Spearman Rho	τ_b	**0.33**	**0.28**	**0.19**
	p	**.**002	**.008**	.079
	EDSE- Motivation			
Kendall Tau	τ_b	**0.181**	**0.284**	0.029
	p	.042	.002	.745
Spearman Rho	τ_b	**0.213**	**0.339**	0.031
	p	.044	.001	.775
	EDSE- Success			

Kendall Tau	τ_b	**0.184**	0.142	*0.167*
	p	.033	.107	.055
Spearman Rho	τ_b	**0.219**	0.174	*0.203*
	p	.037	.106	.054
	EDSE- Anxiety			
Kendall Tau	τ_b	-0.121	-0.018	-0.113
	p	.159	.833	.192
Spearman Rho	τ_b	-0.15	-0.024	-0.134
	p	.157	.821	.204

Note: **Bold** indicates significant at the 95% confidence level

Underline and italics indicate moderately significant at 90% confidence level

Table 4) Kendall Tau and Spearman Rho for professional identity and prior experiences

Table 4 shows the three types of previous experiences (tools, activities, and mindset) tested with Kendall Tau and Spearman Rho to explore to what extent to these prior experiences correlate with the three professional dispositions (Maker, Designer, and Engineer). In this comparison, students Maker disposition is significantly positively correlated with their prior experiences of tools, activities, and mindset, although with a moderate strength of association. Design disposition is significantly positively correlated with their prior experience of tools, activities, and mindset, although with both moderate and low strengths of association. Engineer disposition is significantly positively correlated with prior experience with tools with a strong strength of association. Engineer disposition also showed significant correlations at the 90% confidence level with prior experiences- activities with a low-level strength of association.

		Maker	Designer	Engineer
	Prior Experience - Tools			
Kendall Tau	τ_b	**0.258**	**0.225**	**0.414**
	p	.004	.013	.000
Spearman Rho	τ_b	**0.303**	**0.26**	**0.476**
	p	.003	.014	.000
Prior Experience - Activities				
Kendall Tau	τ_b	**0.248**	**0.229**	*0.159*
	p	.004	.010	*.071*
Spearman Rho	τ_b	**0.3**	0.273	*0.195*
	p	.004	.101	*.065*
	Prior Experience-Mindset			
Kendall Tau	τ_b	**0.225**	**0.208**	0.022
	p	.017	.030	.820
Spearman Rho	τ_b	**0.249**	**0.23**	0.024
	p	.017	.031	.823

Note: **Bold** indicates significant at the 95% confidence level

Underline indicates moderately significant at 90% confidence level

Table 5) Spearman Rho and Kendall Tau for professional identity and MAI 1-4 scores

Table 5 shows the first four types of MAI subcategories (procedural knowledge, declarative knowledge, conditional knowledge, information management) tested with Kendall Tau and Spearman Rho to explore to what extent to these prior experiences correlate with the three professional dispositions (Maker, Designer, and Engineer). In this comparison, maker disposition is significantly positively correlated with conditional knowledge with a moderate strength of association. Designer disposition is significantly positively correlated with procedural knowledge and information management with a low strength of association, as well as conditional knowledge with a moderate strength of association.

		Maker	**Designer**	**Engineer**
	Procedural Knowledge			
Kendall Tau	τ_b	0.102	**0.178**	-0.046
	p	.244	.045	.605
Spearman Rho	τ_b	0.121	**0.213**	-0.058
	p	.253	.046	.586
	Declarative Knowledge			
Kendall Tau	τ_b	0.064	0.093	-0.018
	p	.450	.281	.831
Spearman Rho	τ_b	0.077	0.117	-0.024
	p	.469	.277	.819
	Conditional Knowledge			
Kendall Tau	τ_b	**0.237**	**0.242**	0.01
	p	.006	.006	.905
Spearman Rho	τ_b	**0.285**	**0.299**	0.012
	p	.006	.005	.911

	Information Management			
Kendall Tau	τ_b	0.071	**0.19**	-0.029
	p	.400	.026	.735
Spearman Rho	τ_b	0.089	**0.235**	-0.039
	p	.400	.027	.711

Note: **Bold** indicates significant at the 95% confidence level

Underline indicates moderately significant at 90% confidence level

Table 6) Spearman Rho and Kendall Tau for professional identity and MAI scores 5-8

Table 6 shows the following MAI subcategories- debugging strategies, planning, comprehension monitoring, and evaluation tested with Kendall Tau and Spearman Rho to explore to what extent to these prior experiences correlate with the three professional dispositions (Maker, Designer, and Engineer). Maker disposition only had significant correlations at the 90% confidence level with debugging strategies. Designer Disposition also had a significant positive correlation with evaluation, with a low strength of association.

		Maker	Designer	Engineer
	Debugging Strategies			
Kendall Tau	τ_b	*0.144*	0.128	0.041
	p	*.096*	.146	.636
Spearman Rho	τ_b	*0.175*	0.157	0.055
	p	*.098*	.145	.602
	Planning			
Kendall Tau	τ_b	-0.024	0.068	0.081
	p	.782	.429	.340
Spearman Rho	τ_b	-0.031	0.085	0.101
	p	.769	.429	.342
	Comprehension Monitoring			

Kendall Tau	τ_b	-0.002	0.141	0.041
	p	.982	.101	.634
Spearman Rho	τ_b	-0.001	0.175	0.048
	p	.993	.102	.655
	Evaluation			
Kendall Tau	τ_b	-0.032	**0.18**	0.066
	p	.708	.038	.442
Spearman Rho	τ_b	-0.037	**0.214**	0.078
	p	.728	.045	.463

Note: **Bold** indicates significant at the 95% confidence level

Underline indicates moderately significant at 90% confidence level

Table 7) Spearman Rho and Kendall Tau for EDSE Scores and MAI Scores 1 and 2

Table 7 shows the procedural knowledge and declarative knowledge (MAI scores 1,2) ran with the four EDSE lenses (confidence, motivation, success, anxiety) to test Kendall Tau and Spearman Rho. In this comparison, procedural knowledge is significantly positively correlated with EDSE lenses motivation and expectation of success with a moderate strength of association. Declarative knowledge had significant correlations at the 90% confidence level with motivation with low strength of association.

		Procedural Knowledge	**Declarative Knowledge**
	EDSE- Confidence		
Kendall Tau	τ_b	0.12	0.06
	p	.133	.405
Spearman Rho	τ_b	0.15	0.09
	p	.137	.381
	EDSE- Motivation		
Kendall Tau	τ_b	**0.247**	*0.153*
	p	.002	*.052*
Spearman Rho	τ_b	**0.321**	*0.199*

	p	.002	*.056*
EDSE- Success			
Kendall Tau	τ_b	**0.211**	0.124
	p	.008	.105
Spearman Rho	τ_b	**0.281**	0.165
	p	.006	.113
EDSE- Anxiety			
Kendall Tau	τ_b	0.045	0.024
	p	.567	.751
Spearman Rho	τ_b	0.06	0.05
	p	.566	.631

Note: **Bold** indicates significant at the 95% confidence level

Underline indicates moderately significant at 90% confidence level

Table 8) Spearman Rho and Kendall Tau for Prior experiences and MAI scores 1 and 2

Table 8 shows procedural knowledge and declarative knowledge (MAI scores 1 and 2) tested with Kendall Tau and Spearman Rho to explore to what extent to these prior experiences (tools, activities, and mindset) are correlated. Declarative knowledge only had significant correlations at the 90% level with prior experiences- activities, although with a low strength of association.

		Procedural Knowledge	Declarative Knowledge
	Prior Experience - Tools		
Kendall Tau	τ_b	0.077	0.063
	p	.343	.419
Spearman Rho	τ_b	0.1	0.081
	p	.339	.436
	Prior Experience - Activities		
Kendall Tau	τ_b	0.124	*0.129*
	p	.118	*.095*
Spearman Rho	τ_b	0.163	*0.178*
	p	.116	*.086*
	Prior Experience- Mindset		
Kendall Tau	τ_b	0.134	0.059
	p	.120	.482
Spearman Rho	τ_b	0.162	0.074
	p	.119	.478

Note: **Bold** indicates significant at the 95% confidence level

Underline indicates moderately significant at 90% confidence level

Table 9) Spearman Rho and Kendall Tau for EDSE Scores and MAI Scores 3 and 4

Table 9 shows two of the subcategories of MAI (conditional knowledge and information management) tested with Kendall Tau and Spearman Rho to explore to what extent are the four lenses of EDSE (confidence, motivation, success, and anxiety) correlated. Conditional knowledge is significantly positively correlated with confidence, motivation, success, and anxiety, the lenses confidence, motivation, and success show a moderate strength of association. Information management also had a significant positive correlation with student's confidence, motivation, and success. Information management when ran with motivation and success both has a moderate strength of association.

		Conditional Knowledge	Information Management
	EDSE- Confidence		
Kendall Tau	τ_b	**0.21**	**0.13**
	p	.009	*.079*
Spearman Rho	τ_b	**0.26**	**0.18**
	p	.010	*.084*
	EDSE- Motivation		
Kendall Tau	τ_b	**0.296**	**0.269**
	p	0	.001
Spearman Rho	τ_b	**0.377**	**0.366**
	p	0	0
	EDSE- Success		
Kendall Tau	τ_b	**0.227**	**0.181**
	p	.004	.017
Spearman Rho	τ_b	**0.298**	**0.25**
	p	.004	.015
	EDSE- Anxiety		
Kendall Tau	τ_b	**0.128**	0.069
	p	.009	.358
Spearman Rho	τ_b	*0.171*	0.101
	p	*.098*	.334

Note: **Bold** indicates significant at the 95% confidence level

Underline indicates moderately significant at 90% confidence level

Table 10) Spearman Rho and Kendall Tau for prior experiences and MAI Scores 3 and 4

Table 10 shows the three previous experiences (tools, activities, and mindset) tested with Kendall Tau and Spearman Rho to explore to what extent to these MAI categories (conditional knowledge and Information management) are correlated. Conditional knowledge had a significant positive correlation with prior experiences-activities with a low strength of association.

		Conditional Knowledge	Information Management
	Prior Experience - Tools		
Kendall Tau	τ_b	0.068	0.05
	p	.399	.518
Spearman Rho	τ_b	0.09	0.072
	p	.391	.493
	Prior Experience - Activities		
Kendall Tau	τ_b	**0.167**	0.009
	p	.033	.905
Spearman Rho	τ_b	**0.224**	0.009
	p	.03	.935
	Prior Experience-Mindset		
Kendall Tau	τ_b	0.12	0.059
	p	.159	.479

Spearman Rho	τ_b	0.143	0.075
	p	.169	.475

Note: **Bold** indicates significant at the 95% confidence level

Underline indicates moderately significant at 90% confidence level

Table 11) Spearman Rho and Kendall Tau for EDSE Scores and MAI Scores 5 and 6

Table 11 shows the four lenses of EDSE scores (confidence, motivation, success, and anxiety) tested with Kendall Tau and Spearman Rho to explore to what extent to these EDSE scores correlate with MAI categories- Debugging strategies and Planning. Debugging strategies is significantly positively correlated with confidence (low strength of association), motivation (moderate strength of association), and anxiety with a low strength of association.

		Debugging strategies	**Planning**
	EDSE- Confidence		
Kendall Tau	τ_b	**0.15**	0.07
	p	*.062*	.330
Spearman Rho	τ_b	**0.19**	0.10
	p	*.069*	.363
	EDSE- Motivation		
Kendall Tau	τ_b	**0.251**	**0.212**
	p	.002	.007
Spearman Rho	τ_b	**0.318**	**0.274**
	p	.002	.008
	EDSE- Success		
Kendall Tau	τ_b	0.113	**0.18**
	p	.147	.018

Spearman Rho	τ_b	0.145	**0.221**
	p	.162	.032
	EDSE- Anxiety		
Kendall Tau	τ_b	**0.14**	0.091
	p	*.070*	.229
Spearman Rho	τ_b	**0.19**	0.128
	p	*.066*	.218

Note: **Bold** indicates significant at the 95% confidence level

Underline indicates moderately significant at 90% confidence level

Table 12) Spearman Rho and Kendall Tau for prior experiences and MAI Scores 5 and 6

Table 12 shows the three prior experiences (tools, activities, and mindset) tested with Kendall Tau and Spearman Rho to explore to what extent to these prior experiences are correlated with the MAI categories debugging strategies and planning.

		Debugging strategies	**Planning**
	Prior Experience - Tools		
Kendall Tau	τ_b	0.099	0.067
	p	.215	.395
Spearman Rho	τ_b	0.127	0.08
	p	.222	.443
	Prior Experience - Activities		
Kendall Tau	τ_b	0.102	0.007
	p	.193	.931
Spearman Rho	τ_b	0.138	0.018
	p	.186	.864
	Prior Experience- Mindset		

Kendall Tau	τ_b	0.103	0.046
	p	.226	.581
Spearman Rho	τ_b	0.116	0.054
	p	.264	.603

Note: **Bold** indicates significant at the 95% confidence level

Underline indicates moderately significant at 90% confidence level

Table 13) Spearman Rho and Kendall Tau for EDSE Scores and MAI Scores 7 and 8

Table 13 shows MAI scores 7 and 8 (comprehension monitoring and evaluation) tested with Kendall Tau and Spearman Rho to explore to what extent are these MAI categories correlated with the four EDSE lenses (confidence, motivation, success, and anxiety). Comprehension monitoring shows significant positively correlation with motivation and success both with moderate strengths of association. Evaluation shows significant positive correlations with confidence, motivation (moderate strength of association), and success.

		Comprehension Monitoring	**Evaluation**
	EDSE- Confidence		
Kendall Tau	τ_b	0.12	**0.15**
	p	*.102*	*.049*
Spearman Rho	τ_b	*0.18*	**0.20**
	p	*.092*	*.048*
	EDSE- Motivation		
Kendall Tau	τ_b	**0.318**	**0.315**
	p	.000	.000
Spearman	τ_b	**0.414**	**0.399**

Rho			
	p	.000	.000
	EDSE- Success		
Kendall Tau	τ_b	**0.191**	**0.167**
	p	.012	.030
Spearman Rho	τ_b	**0.249**	**0.224**
	p	.016	.030
	EDSE- Anxiety		
Kendall Tau	τ_b	*0.13*	0.104
	p	*.084*	.171
Spearman Rho	τ_b	*0.186*	0.142
	p	*.072*	.172

Note: **Bold** indicates significant at the 95% confidence level

Underline indicates moderately significant at 90% confidence level

Table 14) Spearman Rho and Kendall Tau for prior experiences and MAI Scores 7 and 8

Tableb14 shows the three categories of prior experiences (tools, activities, and mindset) tested with Kendall Tau and Spearman Rho to explore to what extent these prior activities correlate with these two MAI categories (comprehension monitoring and evaluation).

		Comprehension Monitoring	**Evaluation**
	Prior Experience - Tools		
Kendall Tau	τ_b	0.023	0.046
	p	.766	.561
Spearman Rho	τ_b	0.032	0.057
	p	.760	.588

	Prior Experience - Activities		
Kendall Tau	τ_b	0.037	0.053
	p	.630	.495
Spearman Rho	τ_b	0.05	0.069
	p	.633	.509
	Prior Experience- Mindset		
Kendall Tau	τ_b	0.058	0.043
	p	.485	.607
Spearman Rho	τ_b	0.066	0.049
	p	.525	.636

Note: **Bold** indicates significant at the 95% confidence level

Underline indicates moderately significant at 90% confidence level

Table 15) Spearman Rho and Kendall Tau for prior experiences and EDSE scores

Table 15 shows the four lenses of EDSE scores (confidence, motivation, success, and anxiety) tested with Kendall Tau and Spearman Rho to explore to what extent are these EDSE score correlated with the three previous experiences (tools, activities, and mindset). Prior experiences with tools showed significantly positive correlations with confidence with a moderate strength of association. Prior experiences as well as prior experiences with activities showed a negative correlation with anxiety with a low strength of association.

		Prior Experience - Tools	**Prior Experience- Activities**	**Prior Experience - Mindset**
	EDSE- Confidence			
Kendall Tau	τ_b	**0.23**	0.13	0.01
	p	.005	*.101*	.885

Spearman Rho	τ_b	**0.29**	0.16	0.02
	p	.004	.120	.881
	EDSE- Motivation			
Kendall Tau	τ_b	0.053	0.109	0.139
	p	.519	.175	.111
Spearman Rho	τ_b	0.066	0.146	0.163
	p	.530	.163	.119
	EDSE- Success			
Kendall Tau	τ_b	*0.135*	0.077	-0.129
	p	*.091*	.324	.130
Spearman Rho	τ_b	*0.178*	0.104	-0.154
	p	*.087*	.320	.138
	EDSE- Anxiety			
Kendall Tau	τ_b	**-0.159**	**-0.186**	-0.135
	p	.044	.017	.108
Spearman Rho	τ_b	**-0.212**	**-0.148**	-0.167
	p	.040	.016	.108

Note: **Bold** indicates significant at the 95% confidence level

Underline indicates moderately significant at 90% confidence level

Table 16) Mann-Whitney U test results Grouping Variable: First generation College student

Table 16 shows the output for Mann Whitney U test based off the grouping variable first generation college student.

	Mann Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
EDSE Confidence	970.5	1565.5	-0.393	0.694
EDSE Motivated	975	2745	-0.228	0.819
EDSE Successful	962	2792	-0.461	0.645
EDSE Anxiety	866.5	2696.5	-1.215	0.224
Procedural Knowledge	941	1536	-0.632	0.527
Declarative Knowledge	914	2744	-0.838	0.402
Conditional Knowledge	1016	2846	-0.032	0.975
Information Management	802	2632	-1.72	0.085
Debugging Strategies	835.5	2665.5	-1.469	0.142
Planning	848	2678	-1.359	0.174
Comprehension Monitoring	750	2580	-2.132	0.033
Evaluation	940	2770	-0.633	0.527
Individual Experience with tools	857	1452	-1.309	0.19
Making Activities	889	1484	-1.043	0.297
Making Mindset	828	1423	-1.615	0.106
Do you consider yourself a maker?	808.5	1369.5	-1.314	0.189
Do you consider yourself to be a designer?	736.5	1201.5	-1.262	0.207
Do you consider yourself to be an engineer?	905.5	2735.5	-0.227	0.82

Table 17) Mann-Whitney U test results Grouping Variable: Gender

Table 17 shows the output for Mann Whitney U test based off the grouping variable gender.

	Mann Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
EDSE Confidence	610	910	-2.014	0.044
EDSE Motivated	585.5	861.5	-1.999	0.046
EDSE Successful	634	934	-1.803	0.071
EDSE Anxiety	778.5	1078.5	-0.536	0.592
Procedural Knowledge	736.5	3220.5	-0.922	0.357
Declarative Knowledge	774	3259	-0.575	0.565
Conditional Knowledge	742	3227	-0.862	0.389
Information Management	769	3254	-0.617	0.537
Debugging Strategies	787	3272	-0.465	0.642
Planning	785.5	1085.5	-0.474	0.635
Comprehension Monitoring	777.5	1077.5	-0.544	0.587
Evaluation	692	992	-1.291	0.197
Individual Experience with tools	726.5	3211.5	-1.005	0.315
Making Activities	707	1007	-1.166	0.243
Making Mindset	575.5	875.5	-2.452	0.014
Do you consider yourself a maker?	798	3076	-0.058	0.954
Do you consider yourself to be a designer?	700	953	-0.269	0.788
Do you consider yourself to be an engineer?	617	2963	-1.667	0.096

Table 18) Mann-Whitney U test results Grouping Variable: Underrepresented minority

Table 18 shows the output for Mann Whitney U test based off the grouping variable underrepresented minority.

	Mann Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
EDSE Confidence	501	732	-1.005	0.315
EDSE Motivated	533	764	-0.531	0.595
EDSE Successful	579	810	-0.104	0.917
EDSE Anxiety	512.5	743.5	-0.869	0.385
Procedural Knowledge	560	791	-0.328	0.743
Declarative Knowledge	498	729	-1.035	0.3
Conditional Knowledge	555.5	786.5	-0.376	0.707
Information Management	482	713	-1.217	0.224
Debugging Strategies	492	723	-1.113	0.266
Planning	486.5	717.5	-1.166	0.243
Comprehension Monitoring	459	690	-1.481	0.139
Evaluation	553.5	784.5	-0.397	0.691
Individual Experience with tools	489.5	720.5	-1.148	0.251
Making Activities	371.5	1967.5	-2.508	0.012
Making Mindset	558	2154	-0.372	0.71
Do you consider yourself a maker?	487.5	718.5	-0.89	0.373
Do you consider yourself to be a designer?	409	1840	-0.969	0.333
Do you consider yourself to be an engineer?	517.5	2002.5	-0.304	0.761

V. Results and Discussion

The following section breaks down the results of the research questions:

1. How correlated are students engineering design self-efficacy and engineering professional identity?

Hypothesis	Test	Result
Ho: There will be no significance between students EDSE Confidence score and engineering identity disposition H1: There will be a significant correlation between students EDSE confidence score and engineering identity disposition	Spearman Rho Kendall Tau	Reject the null hypothesis
Ho: There will be no significance between students EDSE motivation score and engineering identity disposition H1: There will be a significant correlation between students EDSE motivation score and engineering identity disposition	Spearman Rho Kendall Tau	Accept the null hypothesis
Ho: There will be no significance between students EDSE successful score and engineering identity disposition H1: There will be a significant correlation between students EDSE successful score and engineering identity disposition	Spearman Rho Kendall Tau	Reject the null hypothesis
Ho: There will be no significance between students EDSE anxiety score and engineering identity disposition H1: There will be a significant correlation between students EDSE anxiety score and engineering identity disposition	Spearman Rho Kendall Tau	Accept the null hypothesis

Based upon the Spearman Rho and Kendall Tau outputs that ran the engineering identity dispositions with the four lenses of EDSE (confidence, motivation, success, and anxiety) there were two key results. Engineer identity had positive significant correlations at the 90% level with EDSE lens confidence as well as expectation of success. Both trends were low levels of association. Due to these trends the null hypothesis was deemed to be rejected for the EDSE lenses of confidence and motivation. When looking at the

broader results of the three professional dispositions (maker and designer) and comparing them to the outputs for engineer it is interesting to note that there were stronger trends among students who identified as a maker and designer with EDSE scores of confidences and motivation.

2. How correlated are students engineering design self-efficacy and professional design identity?

Hypothesis	Test	Result
Ho: There will be no significance between students EDSE Confidence score and designer identity disposition H1: There will be a significant correlation between students EDSE confidence score and designer identity disposition	Spearman Rho Kendall Tau	Reject the null hypothesis
Ho: There will be no significance between students EDSE motivation score and designer identity disposition H1: There will be a significant correlation between students EDSE motivation score and designer identity disposition	Spearman Rho Kendall Tau	Reject the null hypothesis
Ho: There will be no significance between students EDSE successful score and designer identity disposition H1: There will be a significant correlation between students EDSE successful score and designer identity disposition	Spearman Rho Kendall Tau	Accept the null hypothesis
Ho: There will be no significance between students EDSE anxiety score and designer identity disposition H1: There will be a significant correlation between students EDSE anxiety score and designer identity disposition	Spearman Rho Kendall Tau	Accept the null hypothesis

Based upon the outputs for the Spearman Rho and Kendall Tau for the professional disposition designer ran with the EDSE lenses (confidence, motivation, success, and anxiety) two of the null hypothesis were rejected. The professional

disposition designer showed to have a positive correlation among confidence and motivation. Between the professional disposition designer and motivation, a moderate strength of association was noted. This trend potentially indicated students who self-identify as a designer have higher scores of EDSE motivation.

3.How correlated are students engineering design self-efficacy and making identity?

Hypothesis	Test	Result
Ho: There will be no significance between students EDSE Confidence score and maker identity disposition H1: There will be a significant correlation between students EDSE confidence score and maker identity disposition	Spearman Rho Kendall Tau	Reject the null hypothesis
Ho: There will be no significance between students EDSE motivation score and maker identity disposition H1: There will be a significant correlation between students EDSE motivation score and maker identity disposition	Spearman Rho Kendall Tau	Reject the null hypothesis
Ho: There will be no significance between students EDSE successful score and maker identity disposition H1: There will be a significant correlation between students EDSE successful score and maker identity disposition	Spearman Rho Kendall Tau	Reject the null hypothesis
Ho: There will be no significance between students EDSE anxiety score and maker identity disposition H1: There will be a significant correlation between students EDSE anxiety score and maker identity disposition	Spearman Rho Kendall Tau	Accept the null hypothesis

In comparison the professional identity of maker had the most trends when analyzing the intersections of professional identities and EDSE scores. In total there were three positively correlated trends among the maker identity and the following three EDSE lenses- confidence, motivation, and success. Of those three positive correlations maker identity had the strongest moderate strength of association with EDSE confidence. This

trend indicates that potentially students who self-identify as a maker have a higher EDSE score of confidence when approaching engineer design.

4. How correlated are students engineering design self-efficacy and MAI scores?

Hypothesis	Test	Result
Ho: There will be no significant correlation between students EDSE scores and MAI scores. H1: There will be significant correlation between students EDSE scores and MAI scores.	Spearman Rho Kendall Tau Mann Whitney U	Reject the null hypothesis

When analyzing this section of intersection of Spearman Rho and Kendall Tau outputs of the four lenses of EDSE scores and the eight MAI categories it was apparent that there were several notable trends indicating to reject the null hypothesis. To begin the MAI category procedural knowledge showed to have a significant positive correlation trend with EDSE scores of motivations and success. The strength of association showed to be a moderate relationship between both EDSE lenses. This information potentially identifies that student who use procedural knowledge skills more often tend to be more motivated and successful when conducting engineering design. Conditional knowledge as well had three significant positive correlations with EDSE scores of confidence, motivation, and success. All three of these trends had a moderate strength of association. Information management also had a significantly positive correlation with EDSE motivation although with a moderate strength of association. These trends overall potentially indicate that students who use these metacognitive awareness skills such as information management, conditional knowledge, and procedural knowledge also have more success, motivation, and confidence when approaching engineering design. Due to

these trends noted it was appropriate to reject the null hypothesis.

5. How correlated are students' professional identities such as engineering, designing, and making with their MAI scores?

Hypothesis	Test	Result
Ho: There will be no significant correlation between student's professional identity dispositions and their MAI scores. H1: There will be significant correlation between student's professional identity dispositions and their MAI scores.	Spearman Rho Kendall Tau	Accept the null hypothesis

Due to analyzing all the intersections of the Kendall Tau and Spearman Rho ran for the eight MAI categories and the three professional dispositions (maker, designer, and engineer), there were only two notable significant trends. Both maker and designer had a significantly positive trend with conditional knowledge with a moderately strength of association. This indicated that potentially students who self-identify as either maker or designer use more conditional knowledge skills.

When discussing demographics, the Mann Whitney U test outputs show few statistically significant differences. One prominent trend did include male students showed to be significantly higher in engineering design self-efficacy scores specifically within the lenses of motivation and confidence.

VI. Conclusions and Future Work

Overall, these research findings indicated a few positive trends that further need to be explored. Such as how prevalent previous experiences were in student's likeliness of identifying in one of the three professional dispositions. Further research should expand on where students gain the most previous experiences that influence their self-reluctance to identify as one of the professional dispositions. Beyond that these results indicated early on that student with high scores of self-efficacy are more likely to identify as one of the professional dispositions as well, further research could potentially explore what outside influences cultivate motivation, success, and confidence when approaching engineering design.

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