Engineering Disciplines of Undergraduates and Gender Comparison of Creative Self-Efficacy, Mindset, and Perceptions

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Abstract—**This research full paper is a continuation of prior research and considers creativity and engineering in the investigation of why certain engineering disciplines are more popular with women. Creativity in engineering is appealing to women, and women are known to enjoy the design aspect of engineering. This portion of the study involves a gender comparison of creative self-efficacy (CSE), mindset, and perceptions of undergraduate engineering students in ten disciplines. From these perspectives, investigation into why certain disciplines have higher percentages of women needs further investigation. Prior research employed a mixed methods study that focused on CSE, mindset, and lived experiences of women in undergraduate engineering majors. Findings revealed that CSE and mindset contributed to life experiences. In a second study, the survey was distributed to engineering students at all levels and genders, and to working engineers. Analysis of a subset of undergraduate women and men in different disciplines helped to answer the research question, "How do CSE, mindset, and perceptions of engineering as creative compare for women and men in different engineering disciplines?" Comparisons of GPA, CSE, mindset, and perceptions of engineering as creative were analyzed of respondents in biological, architectural, biomedical, chemical, electrical, civil structural, civil environmental, mechanical, industrial, and computer engineering. Initial findings revealed that (1) in biomedical, women had higher GPA; (2) in mechanical. women had higher growth creative mindset (GCM) and lower fixed creative mindset (FCM); (3) in computer, men had higher GCM; and (4) in mechanical and civil environmental, women reported stronger agreement that engineering is creative.**

Keywords—***engineering, undergraduate, gender, female, male, discipline, creative self-efficacy, creative mindset, perceptions***

I. INTRODUCTION

Why do so few women enter engineering and why have the percentages increased very slowly in the 20-year span [1] - [3]? Studies have sought to answer these questions from a variety of perspectives. This study is a continuation of prior research that compares women and men in undergraduate engineering disciplines from the perspective of creative self-efficacy (CSE), mindset, lived experiences, and perceptions of engineering as creative [4]-[6]. A sequential explanatory mixed methods study involved undergraduate women engineering majors [4], [5], and a subsequent study focused on a gender comparison of female and male undergraduate students [6]. This portion of the second study considers creativity in engineering in the analysis of why certain engineering disciplines are more popular with women. It builds on prior research and involves a gender comparison of CSE, mindset, and perceptions of undergraduate engineering students in ten disciplines: architectural, biological, biomedical, civil structural, civil environmental, electrical, mechanical, chemical, computer and industrial.

Creativity is integral to engineering and this aspect of the profession is known to be appealing to women [4]-[8]. Prior research employed a mixed methods study involving synthesis of survey results with qualitative analysis from interviews that focused on CSE, mindset, and lived experiences of undergraduate women engineering majors. Findings revealed that life experiences involving mentors, biases, social norms, and the traditional classroom contributed to CSE and mindset of the participants [10] - [12]. Analysis of different engineering disciplines from the perspective of creativity and CSE and why some disciplines are more welcoming to female students needs further investigation. Female interest and participation in different engineering disciplines has been studied considering attitudes and beliefs [13]-[15]. This portion of the research involves CSE, mindset and perspectives of engineering as creative as factors that could affect a female student's interest and success in certain engineering disciplines.

II. LITERATURE

Women comprise 52% of the educated workforce but only 16% of the engineering workforce, where diverse perspectives are crucial to innovation in the profession [1]-[3], [7]-[9]. In addition, although the percentage of women engineering graduates has recently increased from approximately 20% over the span of 20 years (2000 – 2020), to 24% in 2022 [1]-[3], the number of women in engineering relative to men is still very low, and this recent increase has been attributed more to lower numbers of men entering engineering [3]. Employment percentages of women working in the profession are even lower than the percentages of women graduates, where 15% never enter the field, and 40% leave the engineering profession within 10 years [1]-[3].

A. *Conceptual Framework*

Gender differences in females and males have studied in addressing these low percentages and numbers of women in the engineering profession. Biases in the traditional classroom, social norms, negative perceptions of engineering as a profession for men, and lack of self-efficacy are some of the challenges that female students face that create barriers into engineering [10]-[17]. Self-efficacy of females and males is derived from different sources where females gain self-efficacy from social and emotional factors and males derive it from mastery of specific tasks [16]. Social factors, in addition to academic successes, play an important role in a female student's choice of engineering as a major [9]-[15]. These social factors such as mentors, role models, and friends are known to create positive experiences for female students in the pipeline to engineering and in the major that increase intrinsic motivation, persistence, and growth mindset, contributing to self-efficacy, identification with the engineering major, and ultimately success in the program [9], [13], [16], [17].

The creative aspect of engineering is appealing to women where women engineers have reported enjoying designing, innovation, and devising solutions to open ended problems [4]-[8]. The social and emotional factors leading to a woman's success in the major, have been studied in connection to creativity in engineering, CSE, the two facets of creative mindset: growth creative mindset (GCM) and fixed creative mindset (FCM), and perceptions of engineering as creative [4]-[6]. CSE is the belief in oneself that they can produce a creative product [4]. Notable gender differences in CSE have been reported where women have shown higher CSE than men in social and interpersonal domains whereas men have shown higher CSE than women in the sciences, mathematics, and sports [19]-[23]. This highlights the connection between a female's CSE and social factors.

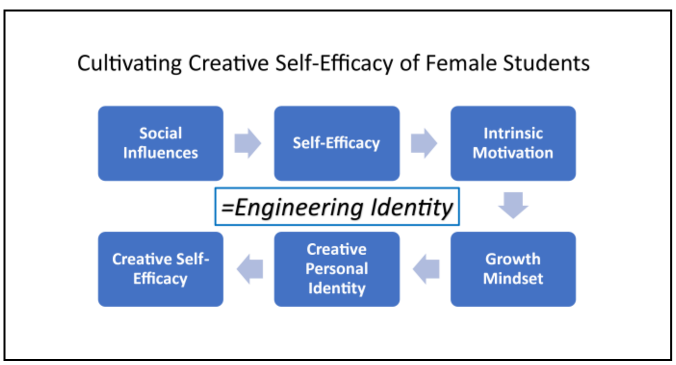

Fig. 1. Conceptual framework: Factors leading to CSE and engineering identity of female students.

Figure 1 depicts the conceptual framework for this study involving the process of cultivating CSE of female students leading to engineering identity and ultimately success in an engineering major. Engineering identity has been studied as a factor leading to the retention and success of students in the major [17]. Social influences are a major contributor to self-efficacy of females leading to intrinsic motivation and growth mindset, which cultivates creative personal identity and CSE. These factors have been studied as being contributors to engineering identity which is known to lead to success in the

TABLE 1. DEGREES AWARDED IN 2022 FOR TEN ENGINEERING DISCIPLINES [2]

Disciplines	**Degrees Awarded in 2021**	**# of Degrees Awarded**		**% of Degrees Awarded**	
		Women	***Men***	***Women***	***Men***
Architectural	**682**	**249**	**433**	**36.5**	**63.5**
Biological*	**1,361**	**558**	**803**	**40.1**	**59.9**
Biomedical	**7,969**	**2,197**	**4,184**	**52.5**	**47.5**
Civil Environmental +	**3027**	**1,268**	**1759**	**41.9**	**58.1**
Civil Structural	**12,678**	**3,436**	**9,242**	**27.1**	**72.9**
Electrical	**16,649**	**2,770**	**13,879**	**16.6**	**83.4**
Mechanical	**32,891**	**5,164**	**27,727**	**17.6**	**82.4**
Chemical	**8,946**	**3,577**	**5,369**	**39.9**	**60.1**
Computer	**8,217**	**1,290**	**6,927**	**15.7**	**84.3**
Industrial **	**6,465**	**2,230**	**4,235**	**34.5**	**65.5**

+Civil Env. and Environmental are combined for this study.
*Includes Agricultural, **Includes Manufacturing

major [9], [11], [17], [25]. Investigation of these factors related to different engineering disciplines is a focus of this study.

B. *Engineering Disciplines and Female Students*

Certain engineering disciplines are known to attract more female students and have higher percentages of women graduates [2], [3], [13], [15]. These majors include biomedical, environmental, chemical, and industrial. Women have reported that such disciplines are more welcoming and have been associated with the desire of women to help others, which has been reported as an expectation in the disciplines with higher percentages of female students [13], [14]. In disciplines that have lower representations of women such as mechanical electrical, and computer, and construction, their expectations aligned with those of men such as making money and inventing things, or engineering design, as factors that attracted them to these majors [13].

Degrees awarded to women in 2021 for ten engineering disciplines are listed In Table 1. Although the discipline with the largest number of degrees awarded to women is mechanical (n=5164), the percentage of degrees awarded to women was one of the lowest (17.5%). Biomedical had the highest percentage of women graduates (n=2197, 52.5%), and environmental and civil environmental combined had the second highest percentage of women graduates (n=2,168, 41.9%) [2]. (The survey choices included civil environmental, so environmental engineering was included with civil environmental in Table 1 in the calculation of percentages in the major for this study. This is because it was expected that respondents would choose this if their major was environmental.)

In 2022, the percentages of some of the engineering disciplines listed in Table 1 are as follows: environmental (32%), industrial (24%), chemical (20%), biomedical (19%), civil (17%), mechanical (9%), electrical (9%) [24]. Thus, the percentages of women working in the profession, even in the more popular disciplines are lower than reported graduates. These statistics highlight challenges in two areas: (1) female students who choose engineering as a major and graduate, and (2) women graduates who enter the field. Female students who major in engineering, choose a particular discipline based on their beliefs, perspectives, and perceptions. To better understand why certain disciplines have higher percentages of

TABLE 2. FREQUENCY TABLE FOR ENGINEERING DISCIPLINES BASED ON GENDER [6]

Discipline	Women		Men	
	Freq.	*%*	*Freq.*	*%*
Other	4	2.0	0	0
Architectural	22	11.2	38	18.0
Biological	21	10.7	17	8.1
Biomedical	22	11.2	21	10.0
Civil Environmental	15	7.6	16	7.6
Civil Structural	31	15.7	23	10.9
Electrical	15	7.6	16	7.6
Mechanical	23	11.7	19	9.0
Chemical	10	5.1	22	10.4
Computer	20	10.2	15	7.1
Industrial	13	6.6	24	11.4
N/A	1	.5	0	0
Total	197	100.0	211	100.0

women, it is important to investigate reasons why women are drawn to these fields. The connection of engineering disciplines that are more popular with female students to creativity in engineering, CSE, mindset and perceptions of engineering as creative, needs further research. This study will offer insight into these relationships and compare those of women to their male counterparts. Better understanding the gender connection of CSE, mindset and perceptions to respective engineering disciplines can help lead to the reform needed to provide a more welcoming educational experience for women in all disciplines.

III. Research Question

The research question that frames this study is, "How do CSE, mindset, and perceptions of engineering as creative compare for women and men in different engineering disciplines?" The answers to this research question will help to offer insight into why certain engineering disciplines are more popular with women, and the connection to CSE, GCM, FCM, and perceptions of engineering as creative

IV. Methodology and Instrument

The instrument used in this study consisted of a CSE assessment, and a measure of creative mindset that was distributed in previous studies [4]-[6] A question that focused on perceptions of engineering as creative was also included in the survey. A five-point Likert scale was used consisting of the following response choices: Strongly Agree, Agree, Neither Agree or Disagree, Disagree, and Strongly Disagree. The Likert scale was numbered from 1-5 for analysis with 5 assigned to the highest level of agreement. Survey responses were sorted into three categories for the analysis [4]-[6]. There were three questions that assessed CSE from a validated questionnaire [25], [26]. There were 10 questions on GCM and 5 questions on FCM [4]-[6]. The sum of the scores for each category was analyzed quantitatively in this portion of the study for the subset of data comprised of undergraduate engineering majors. An additional question on perspectives of engineering as creative was included. Quantitative analysis of the data including means, standard deviations, and independent t-tests helped to answer the research question.

V. Population

The survey was distributed nationally to engineering students of all genders and levels and to engineers in the field through the Society of Women Engineers (SWE). The survey was also extended to other engineering professional societies and universities. There were 704 valid responses to the distribution, and a subset of responses comprised of declared undergraduate engineering majors was analyzed in this portion of the study. Out of 443 submissions from respondents who indicated in the demographics section that they were undergraduate engineering students, there were 411 respondents who completed all questions on CSE, GCM, and FCM, 48% (N= 197) female and 51.5% (N= 211) male. Valid responses to the survey included completed surveys. Two genders, declared female, and declared male students were analyzed with respect to engineering discipline for this portion of the study [6]. The pool of respondents from other gender designations was not large enough to analyze. These respondents can be considered in future studies [6].

VI. Findings and Discussion

Demographic information with respect to engineering disciplines, and analysis of means and correlations of GPA, CSE, GCM, FCM, and perceptions of engineering as a creative field, revealed differences and similarities in responses of men and women for the ten engineering disciplines. The findings

revealed significant differences in several analyzed parameters for the disciplines that highlighted gender differences in numbers or percentages in the reported statistics in Table 1, namely biomedical, civil environmental, mechanical, and computer engineering.

A. *Demographic Information on Engineering Discipline.*

Table 2 lists the engineering disciplines reported by the declared undergraduate students. The disciplines in this portion of the study that had the largest percentage of women were civil structural (n=31, 15.7%), mechanical (n=23, 11.7%), architectural (n=22, 11.2%), and biomedical (n=22, 11.2%). The disciplines that had the highest numbers of men who completed the survey were architectural (n=38, 18%), industrial (n=24, 11.4%), civil structural (n=23, 10.9%), and chemical (n=22, 10.4%) [6]. Respondents that entered “Other” are not included in this analysis.

B. *Analysis of Means and Independent t-Test*

Table 3 depicts gender comparisons of means and standard deviations of GPA, CSE, GCM, and FCM for ten engineering disciplines. The means are the averages of the strength of agreement with the question, where the scale is numbered from 1-5, and the strongest agreement is a 5. Table 4 depicts analysis of comparisons with respect to F-test, t-test, and correlations. The highlighted areas in Table 3 reveal significant gender differences in the parameter for the respective discipline that are specified in Table 4. There was no significant difference in CSE for all ten engineering disciplines. Although CSE, GCM, and FCM were the same for women and men in the biomedical engineering major, women had a significantly higher mean GPA range than their male counterparts (i.e. women: $\mu = 4.1364$, men: $\mu = 3.1905$).

TABLE 3. MEANS AND STANDARD DEVIATIONS: GPA, CSE, GCM, AND FCM

Summary of Gender Comparisons of Means for GPA, CSE, GCM, FCM Based on Engineering Discipline									
Discipline (W = # Women, M = # Men)	***Statistic***	***GPA***		***CSE***		***GCM***		***FCM***	
		W	***M***	***W***	***M***	***W***	***M***	***W***	***M***
Architectural (W 21, 10.7%, M 38, 18%)	**Mean**	3.5238	3.5526	11.546	11.158	36.955	38.316	17.864	18.421
	S.D.	0.9284	1.2455	1.6541	2.0863	4.4345	6.0189	3.4128	3.5078
Biological (W 21, 10.7%, M 17, 8.1%)	**Mean**	3.4762	3.2941	11.286	10.941	36.619	35.765	17.429	17.765
	S.D.	1.1670	1.1048	2.3269	1.6760	4.7379	4.4795	3.3102	3.4192
Biomedical (W 22, 11.2%, M 21,10%)	**Mean**	**4.1364**	**3.1905**	10.409	10.429	36.636	35.429	16.773	18.191
	S.D.	1.1253	1.2892	2.0156	2.1348	4.5203	4.7071	3.2650	2.4004
Civil Environmental (W 15, 7.7% , M 16, 7.6%)	**Mean**	3.3333	3.7500	9.6667	10.250	**33.667**	**36.500**	18.467	18.750
	S.D.	1.1751	1.1832	2.5542	2.0817	4.9952	3.5963	2.9968	1.9833
Civil Structural (W 31, 5.8% , M 23, 0.9%)	**Mean**	3.6774	3.2174	10.355	10.391	36.452	34.826	16.871	17.652
	S.D.	1.0452	1.0426	2.0583	2.0391	4.1137	3.8216	2.8606	2.4974
Electrical (W 15, 7.7% , M 16, 7.6%)	**Mean**	3.3333	3.6250	11.400	10.375	38.733	36.750	17.733	16.625
	S.D.	1.0465	1.0247	2.2929	2.2767	4.1998	3.9412	3.9364	3.0304
Mechanical (W 23, 11.7%, M 19, 9.0%)	**Mean**	3.8261	3.7368	10.739	10.895	**37.522**	**34.79**	**16.130**	**18.263**
	S.D.	1.2304	1.1471	2.4728	1.7287	5.2473	4.7443	3.5201	2.0775
Chemical (W 10, 5.1%, M 22,10.4%)	**Mean**	3.6000	3.2727	10.200	10.591	34.700	35.909	16.700	18.227
	S.D.	1.450	1.2793	2.1499	1.7904	2.9458	3.4215	1.5670	2.67140
Computer (W 20, 10.2%, M 15, 7.1%)	**Mean**	3.8000	3.9333	10.500	10.467	**33.850**	**36.533**	17.300	17.867
	S.D.	1.1517	0.7988	2.0647	1.9952	3.4985	3.9797	2.4730	2.7220
Industrial (W 13, 6.6%, M 24, 11.4%)	**Mean**	3.7692	3.3333	10.5385	10.500	36.5385	35.0417	16.692	18.0417
	S.D.	1.0127	1.0072	1.9415	2.2842	3.9920	3.0571	2.9265	2.3309
Total (W 197, 100%, M 211, 100%)	**Mean**	3.6939	3.4692	10.736	10.649	36.452	36.119	17.107	18.033
	S.D.	1.1178	1.1392	2.1716	2.0096	4.6108	4.4976	3.1190	2.7609

Table 4 shows that women in the mechanical engineering discipline had significantly higher GCM (i.e., women: 37.5217, men: 34.7895), and significantly lower FCM than the men (i.e., women: μ = 16.1304, men: μ = 18.2632), although GPA range and CSE were statistically the same for both groups. However, women in the civil environmental engineering disciplines had a significantly lower GCM than the men (women: μ = 33.6667men: μ = 36.5000), although FCM was statistically the same for both. In the computer engineering major, GPA range, CSE and FCM were the same, however the women had a significantly lower mean GCM than the men (i.e., women: μ = 33.8500, men: μ = 36.5333). Women in mechanical engineering had the highest GCM, and men in the architectural engineering had the highest GCM. Both women and men had the highest FCM in civil environmental engineering (i.e., women: μ = 18.4667, men: μ = 18.7400).

C. Perceptions of Engineering as a Creative Field

Respondents from the ten engineering disciplines were asked their strength of agreement with the statement "Engineering is a creative field." Answer choices ranged from Strongly Agree to Strongly Disagree. Table 5 lists the means for the female and male respondents from the ten engineering disciplines. Women in chemical engineering had the strongest mean level of agreement with the statement (4.3), and women in the mechanical engineering major had the second highest level of agreement (4.17). Men in the civil environmental engineering major had the lowest level of agreement (3.25). It is notable that women in computer engineering had the second lowest strength of agreement (3.30) that included both women and men, and the lowest strength of agreement of the women for the 10 engineering disciplines.

Table 5 highlights the comparison of means (independent t-test) based on gender for the ten engineering disciplines. Levine's F-test of variances was performed to determine if equal or unequal variances should be assumed. A one-sided p was used to test for one parameter being greater than the other. The only major that showed a significant difference in variance, thus unequal variances were assumed for this discipline for the t-test listed in Table 6. The shaded rows in Table 5 highlight a significant difference in agreement with the statement from the comparisons of means in Table 6.

D. Discussion

In this study, biomedical engineering had the highest percentage of women graduates of all engineering disciplines [2]. In addition, women in this major had a significantly higher GPA than the men suggesting that they are high achieving and identify strongly with the major [17]. The literature shows that female mentors, social networks, and support lead to greater identification with the major, greater success, and higher percentages of retention and graduation rates [11], [12]. There was no difference between the women and men in biomedical engineering in the reported strength of agreement with the statement "Engineering is a creative field." Thus, the results of this study suggest that the higher percentage of women in the discipline play a greater distinguishing role in the success of these students in biomedical engineering than CSE or creative mindset. This connects to the literature that supports the importance of female mentors, support groups and social networks in the success of female students in engineering [4]-[6], [9], [11], [12], [17].

Civil environmental/environmental engineering had the

TABLE 4. F-TEST AND INDEPENDENT T-TEST: GPA, CSE, GCM, FCM

Discipline	Parameter	F	Sig.	t	d.f.	1 side p
Architectural	GPA	3.824	.055	-.093	57	.463
	CSE	3.137	.082	.745	58	.230
	GCM	4.024	.050	-.924	58	.180
	FCM	.142	.708	-.599	58	.276
Biological	GPA	.073	.789	.490	36	.314
	CSE	2.065	.159	.512	36	.306
	GCM	.347	.559	.566	36	.287
	FCM	.370	.547	-.307	36	.380
Biomedical	GPA	.659	.422	2.567	41	**.007****
	CSE	.687	.412	-.031	41	.488
	GCM	.031	.861	.858	41	.198
	FCM	2.643	.112	-1.616	41	.057
Civil Environ-mental	GPA	.208	.652	-.983	29	.167
	CSE	.530	.473	-.699	29	.245
	GCM	1.364	.252	-1.821	29	.039*
	FCM	1.586	.218	-.312	29	.379
Civil Structural	GPA	.014	.905	1.601	52	.058
	CSE	.030	.863	-.065	52	.474
	GCM	.016	.899	1.479	52	.073
	FCM	.709	.404	-1.046	52	.150
Electrical	GPA	.026	.874	-.784	29	.220
	CSE	.118	.734	1.248	29	.111
	GCM	.023	.880	1.357	29	.093
	FCM	1.677	.206	.882	29	.193
Mechanical	GPA	.054	.817	.241	40	.405
	CSE	1.595	.214	-.231	40	.409
	GCM	.197	.660	1.753	40	**.044***
	FCM	4.547	**.039+**	-2.437	36.53	**.010***
Chemical	GPA	.517	.478	.647	30	.261
	CSE	1.101	.302	-.538	30	.297
	GCM	.045	.833	-.965	30	.171
	FCM	1.481	.233	-1.673	30	.052
Computer	GPA	1.464	.235	-.384	33	.352
	CSE	.052	.820	.048	33	.481
	GCM	.795	.379	-2.117	33	**.021***
	FCM	.005	.943	-.643	33	.262
Industrial	GPA	.073	.789	1.254	35	.109
	CSE	.188	.667	.051	35	.480
	GCM	.346	.560	1.276	35	.105
	FCM	.450	.507	-1.536	35	.067

+ Unequal variances assumed.
*One-Sided p; Significant at the p= 0.05 level.
** One-Sided p; Significant at the p = 0.01 level.

second highest percentage of women graduates as is shown in Table 1. Although the women respondents had a significantly lower GCM than the men, they had a greater agreement with the statement "Engineering is a creative field." Although the lower GCM suggests that female support and social networks likely play a larger role in the success of women in this discipline than creative mindset, further research is needed to better understand their lower GCM and greater perception that engineering is a creative field.

The mechanical engineering major awards more degrees to women than any other discipline although the percentage of women graduating with a degree in this major is one of the lowest (17.6%), and percentages of women in the field are among the lowest (9%) [2], [24]. The results of this study suggested that women who succeed in the mechanical engineering discipline have stronger beliefs than their male

TABLE 5. MEANS AND S.D. FOR RESPONSE TO "ENGINEERING IS A CREATIVE FIELD"

Discipline	Gender	N	Mean	S.D.
Architectural	Female	22	3.73	1.162
	Male	38	3.87	1.166
Biological	Female	21	3.76	1.261
	Male	17	3.53	1.375
Biomedical	Female	22	3.41	1.008
	Male	21	3.57	1.248
Civil Environmental	Female	15	4.00	1.254
	Male	16	3.25	1.000
Civil Structural	Female	31	3.52	1.208
	Male	23	3.91	.900
Electrical	Female	15	3.67	1.113
	Male	16	3.88	.957
Mechanical	Female	23	4.17	.937
	Male	19	3.58	1.216
Chemical	Female	10	4.30	1.059
	Male	22	3.73	1.077
Computer	Female	20	3.30	1.218
	Male	15	3.67	.900
Industrial	Female	13	3.46	.877
	Male	24	3.46	1.250

counterparts that they can improve creatively in that discipline, and that that creativity is not innate. Conversely, the men in the mechanical engineering major have a stronger belief that their creative talents are innate and cannot change and have a lesser belief that they can improve their creativity with practice.

Mechanical engineering has been categorized as a profession associated with men [13]. Inventing and engineering design are known to be highly creative, and are typically associated with male oriented engineering disciplines [4]-[8]. The connection between women in mechanical engineering and their significantly higher GCM and significantly lower FCM in this study suggests that creative mindset is something that does affect the success of women in this discipline and warrants future research.

Computer engineering (15.7%) and electrical engineering (16.6%) have the lowest percentage of female graduates (see Table 1). Men had a higher GCM than women in the computer engineering major suggesting that men are more likely to perceive themselves as being able to grow creatively in this discipline than the women. This discipline also had one of the highest FCM for both women and men, and it had the lowest FCM for the women of all disciplines.

Therefore, although the two disciplines are similar in how they are categorized as having the lowest percentages of women, these results suggest that female students who are successful in mechanical engineering likely consider themselves as better able to grow creatively in the field than in computer engineering.

VII. CONCLUSION

The four engineering disciplines that were the most distinguishing with respect to gender from the reported statistics, biomedical, civil environmental (with environmental included for this study), mechanical, and computer highlighted significant gender differences in responses to the respective parameters analyzed in this study. Biomedical and civil/environmental have among the highest percentages of female students, whereas

TABLE 6. F-TEST AND INDEPENDENT T-TEST: "ENGINEERING IS A CREATIVE FIELD"

Discipline	F	Sig.	t	d.f.	p
Architectural	**.027**	**.871**	**-.452**	**58**	**.326**
Biological	**1.148**	**.291**	**.543**	**36**	**.295**
Biomedical	**2.822**	**.101**	**-.470**	**41**	**.320**
Civil Environmental	**1.073**	**.309**	**1.847**	**29**	**.037***
Civil Structural	**6.563**	**.013+**	**-1.384**	**51.994**	**.086**
Electrical	**1.298**	**.264**	**-.560**	**29**	**.290**
Mechanical	**4.363**	**.043+**	**1.747**	**33.399**	**.045***
Chemical	**.058**	**.812**	**1.401**	**30**	**.086**
Computer	**4.957**	**.033+**	**-1.024**	**32.999**	**.157**
Industrial	**5.781**	**.022+**	**.009**	**32.448**	**.496**

+ Unequal variances assumed.
*One-sided p, significant at the 0.05 level.

mechanical and computer have among the lowest percentages. Although the statistics did not indicate similarities with respect to the parameters analyzed, these disciplines were distinguished by their statistically significant differences with respect to gender.

The statistically significant higher GCM, lower FCM and perception that engineering is a creative field of the female students in mechanical engineering, are notable, and a deeper investigation into the different disciplines and how they differ in terms of actual practice as well as perceptions, is necessary to better understand these results and how they connect to the significant gender differences reported. A better understanding of why different disciplines are more appealing to women, and why from this study, mindset differs for different disciplines that are less welcoming to female students, can help lead to the educational reform needed in all disciplines to provide a more welcoming atmosphere in engineering for women. Future research includes further analysis of the data, continued investigation of the engineering disciplines and their similarities and differences, and interviews with female and male students in the respective engineering disciplines to learn more about their experiences, focusing on successes, challenges, and perspectives.

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