First-Year Engineering Students' Perceptions of their Abilities to Succeed

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Dr. Wickliff has been blessed since 2013 to work daily in the area of her passion – developing young professionals – in her exciting role at Texas A&M University. She is a Professor of Engineering Practice and Mentor to a group of STEM POSSE Scholars. At Texas A&M University, she has taught Capstone Senior Design, Foundations of Engineering courses, Statics & Dynamics, Ethics and Engineergin, and Engineering Leadership Development courses. She is also the founding director of the Zachry Leadership Program. She has also taught Project Management and Risk Management courses for the University of Phoenix.

Dr. Wickliff has been honored with University of Houston's Distinguished Young Engineering Alumni Award, the Black Engineer of the Year Career Achievement Award for New Emerging Leaders and featured in several publications. She has presented keynote addresses, facilitated workshops and given motivational presentations at numerous civic and corporate forums domestically and internationally. She is a contributing author to Tavis Smiley's book, "Keeping the Faith", with her inspiring life story. She believes that her life's calling and thus career quest is to be a catalyst of signicant, positive change and growth for individuals and entities. However, through it all, Dr. Wickliff gives top priority to her relationship with God, her husband Oscar Smith and her three sons – Jamar Dugat, Raymond Wickliff and Dr. Cortlan Wickliff, Esq.

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First-Year Engineering Students' Perceptions of their Abilities to Succeed

Abstract

The engineering foundation course outcomes identified by the Accreditation Board for Engineering and Technology (ABET) are common across colleges and universities. A group of professors at a university located in the southwestern region of the United States is conducting engineering enculturation research of first-year engineering (FYE) students to the engineering profession. Engineering as a profession has its own norms, values, and practices that are unique to its culture. Students begin to learn and assimilate to this engineering culture of the moment that they begin their academic journey. The literature has indicated that there are several success factors for students during their first year of college in an engineering curriculum. How well a student assimilates to a culture is a key success factor. In research, a person's perception is said to be an important factor that effects both their willingness to persist and successfully achieve their goals. This research can help to inform both literature and practice by shedding empirical insight into factors that enable the successful matriculation of students through their FYE program.

During the FYE foundation class, engineering students, primarily freshman, self-reported on their perceptions of their abilities to perform on the engineering foundation course outcomes as were established by ABET. In this quantitative assessment, the professors analyzed the Likert-scale data collected from 187 engineering students from multiple sections of an engineering foundation course.

Research has shown that a person's belief in their abilities is critical in translating their confidence into successful actions. Likewise, the engineering student's belief in his or her ability to perform foundational math, science, and analytical problem solving skills, as well as be a productive member of a high achieving team, will increase the probability that the student will perform well academically, persist through engineering curricula successfully and become a practicing engineer. This paper contains the initial results from this ongoing research to assess the student's perceptions of ABET foundational engineering outcomes.

I. Introduction

The need for engineers to fill positions in industries throughout the world is increasing. In 2014, globally there were 866,000 engineering jobs available per the data from 22 countries with the world's largest economies (CEB Inc., 2014). As a global leader in the areas of STEM, the United States contains 30% of the world's scientist and engineers and accounts for 40% of research and development spending globally (Fantz, Siller, & DeMiranda, 2011; Freeman, 2005). With several of the world's top universities located in the United States, the world is depending on continuous quality output of graduates and even increased quantities from those universities particularly in the areas of STEM. Fortunately, several of the universities in the Unites States are all in pursuit of a similar, critical quest – to train and graduate more engineers.

On one hand, Zhang, Anderson, Ohland, and Thorndyke (2004) conducted a study of a database of more than 87,000 students from nine institutions over the course of 15 years to assess success factors for their engineering students with a particular focus on various precollege academic aptitude scores, such as high school GPAs and SAT subject scores. On the other hand, a group of researchers focused on perceptions and attitudes of engineering students toward their background knowledge and abilities to be successful in engineering and found subgroup differences, such as by genders and by persisters/non-persisters (Besterfield-Sacre, Atman, & Shuman, 1997; Besterfield-Sacre, Moreno, Shuman, & Atman, 2001). In the analysis of some freshmen students, students' self-perceptions including self-efficacy were found to be a positive predictor of freshman retention (Hutchinson, Follman, Sumpter, & Bodner, 2006). Student research was conducted by a study which consisted of two rounds of surveys from 663 participants to examine the predictability of course grades and again self-efficacy for learning course materials emerged as one of the important factors key to achievement for the students (Stump, Hilpert, Husman, Chung, & Kim, 2011). With the reoccurring theme of students' self-perceptions being a contributor to student success and persisting in college, professors at a large southwestern university decided to take a closer look at this factor as a subset of their funded engineering enculturation research.

A. Enculturation Research Context

Engineering leaders at this southwestern university are pursuing a visionary, aggressive goal of growing their college of engineering to 25,000 quality students by the year 2025. This 25 x 25 Initiative, as it is called, was developed to positively and significantly contribute to the needs of the global engineering workforce by graduating many more highly skilled engineers. In support of that goal, professors from that university are pursuing research to study the enculturation of students to the engineering profession. Enculturation is the process by which an individual learns the traditional content of a culture and assimilates its practices and values (Richard *et al*., 2016). In the study, we began by being mindful of the culture, norms and behaviors of the university and engineering department. From the initial study, we arrived at enculturation factors that have continued to serve as the framework for our research. The university is conservative and rich with traditions that influence the norms and behaviors of the students, faculty and staff. Additionally, the college of engineering is actively engaging its nearly 17,000 students to pursue high impact experiences in the classroom and beyond the walls of the class to improve work force readiness of the students, groom more informed, good global citizens and increase their probability of positive academic and professional success. The university admits more than 3,000 first-year engineering (FYE) students annually and they are all part of the first-year engineering experience. Part of that experience includes two engineering foundation courses that all engineering students are required to take.

These courses are critical is introducing the students to some of the knowledge, practices, and values of the engineering profession. The content of the engineering foundation courses is designed to address the outcomes that are identified by the Accreditation Board for Engineering and Technology (ABET) which are also common to most engineering programs at colleges and universities throughout the United States. The eleven ABET Engineering Student Outcomes (a-k) are the skills that a student should have upon graduation from an accredited university. Below is the list of those ABET outcomes (Engineering Accreditation Commission, 2015).

(a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) an ability to function on multidisciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

In studying the culture of the engineering profession and the expected ABET Engineering Student Outcomes at the southwestern university, the following key enculturation factors were identified and incorporated into the FYE experience (Richard et al., 2016).

1. Problem solving
2. Algorithmic thinking
3. Math and physical modeling
4. Engineering design
5. Engineering communications
6. Teamwork
7. Ethics
8. Engineering profession

B. Purpose of the Study

As a subset of the overall Engineering Enculturation research being performed by the faculty at the southwestern university (Mendoza Diaz *et al.*, 2017; Richard *et al.*, 2017), the primary purposes of this study are two folded: (a) to analyze students' perceptions of their current ability and corresponding academic success of the students in the foundation of engineering; and (b) to find any subgroup differences by gender and majority/minority status in their perceptions of current ability. The student participants were asked to self-report on their perceptions of their ability to perform the engineering student outcomes as set forth by ABET which align with the engineering enculturation outcomes that are taught in the FYE foundation courses. The ABET Engineering Student Outcomes are the practices and attributes believed to be required to become a successful engineer upon graduation from an ABET accredited college or university. When considering these engineering enculturation factors, it is believed that if students' perception of their current ability is high and positive, then it will foster high and positive academic achievement, measured as a final grade of the engineering foundation course.

II. Method

A. Research Design

In this research, the more than 3,600 students enrolled in the first engineering foundation course in fall of 2016 were invited to participate in the enculturation research through an email invitation and announcement in class. The research data collection included the administering of an online survey, including open-ended questions, Likert-scale items, and demographic questions, and focus group discussions. For this portion of the research, the ABET Engineering Student Outcomes were used to create part of the survey instrument that allowed participants to report on their perceptions regarding their current abilities to perform the ABET outcomes and thus some foundational skills of the engineering enculturation factors. The remainder of this paper shares the research details and results of the survey of the perceptions of the students' ability to perform the outcomes of the ABET outcomes.

Students were given a survey that was developed on a seven-point Likert scale for eleven items, which align with the ABET outcomes (See Table 1 for the survey items). The participants were asked to self-report if they strongly agree, moderately agree, agree, were neutral, disagree, moderately disagree or strongly disagree.

Table 1. Survey Questions on ABET Engineering Student Outcomes

A. I have the ability to apply my knowledge of mathematics to solve engineering problems.
B. I have the ability to apply my knowledge of science to solve engineering problems.
C. I have the ability to design a system, component or process to meet desired needs within realistic constraints as an engineer.
D. I have the ability to function well on multidisciplinary teams as an engineer.
E. I have the ability to identify, formulate and solve engineering problems.
F. I have a good understanding of my professional and ethical responsibility as an engineer.
G. I have the ability to communicate effectively (oral and written) as an engineer.
H. I have the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context.
I. I recognize the need for and plan to engage in life-long learning as an engineer.
J. I have knowledge of contemporary issues in engineering.
K. I have the ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

B. Participants

This survey was given to the students in October, 2016 for the first time. The survey will be given again to the students several times for the next two years as pre- and post-measures during the semesters of their freshman and sophomore years. Table 2 shows demographics of 187 students who participated in the survey. The student participants were comprised of 43 females (23%) and 144 males (77%). A diverse group of students participated in the survey. The largest racial/ethnic group was White which comprised 52.4%, followed by Hispanic (27.8%). Of all of the respondents, 52.4% were majority students (White) and 40.1% were minority students (non-White). Race and ethnicity were not characterized for international students who participated in the survey which was 4.8% of the respondents. Of the participants, 151 were freshman or 80.7% and 15% (28 students) were upperclassmen, which are mostly transfer students taking the engineering foundation course to meet the pre-requisite. There was also 4.3% of the respondents, who were part of the branch campuses or Engineering Academies taking the course at their community colleges as joint registered at their two-year and the four-year institutions.

Table 2. Demographics of the participants ($N = 187$)

Category	Subgroup	*n*	%
Gender	Female	43	23.0
	Male	144	77.0
Race/ Ethnicity[a]	Hispanic	52	27.8
	Asian	18	9.6
	Black	5	2.7
	White	98	52.4
	Multiracial	5	2.7
Minority Status	Minority (non-White)	75	40.1
	Majority (White)	98	52.4
Residence	Domestic	178	95.2
	International	9	4.8
Student Level	First Year	151	80.7
	Upper Level	28	15.0
	Branches/Academies	8	4.3
Total		187	100.0

Note. [a]Race/Ethnicity was categorized for domestic students only.

C. Data Analyses

First, descriptive statistics were used to identify trends in the data, and then inferential statistics, such as Pearson correlations and independent samples *t*-tests, were applied to check statistically significant differences between subgroups by gender and minority status at the alpha level of .05. All assumptions for inferential statistics (e.g., independent observation, normality, and homogeneity of variance) were checked before the analyses (Field, 2009).

III. Results

A. Descriptive Statistics

Overall, participant reported a moderately high score of an average of 5.47 on a scale of 7.0 for all of the items. Figure 1 shows the average scores of the eleven ABET outcome items recorded from all of the respondents.

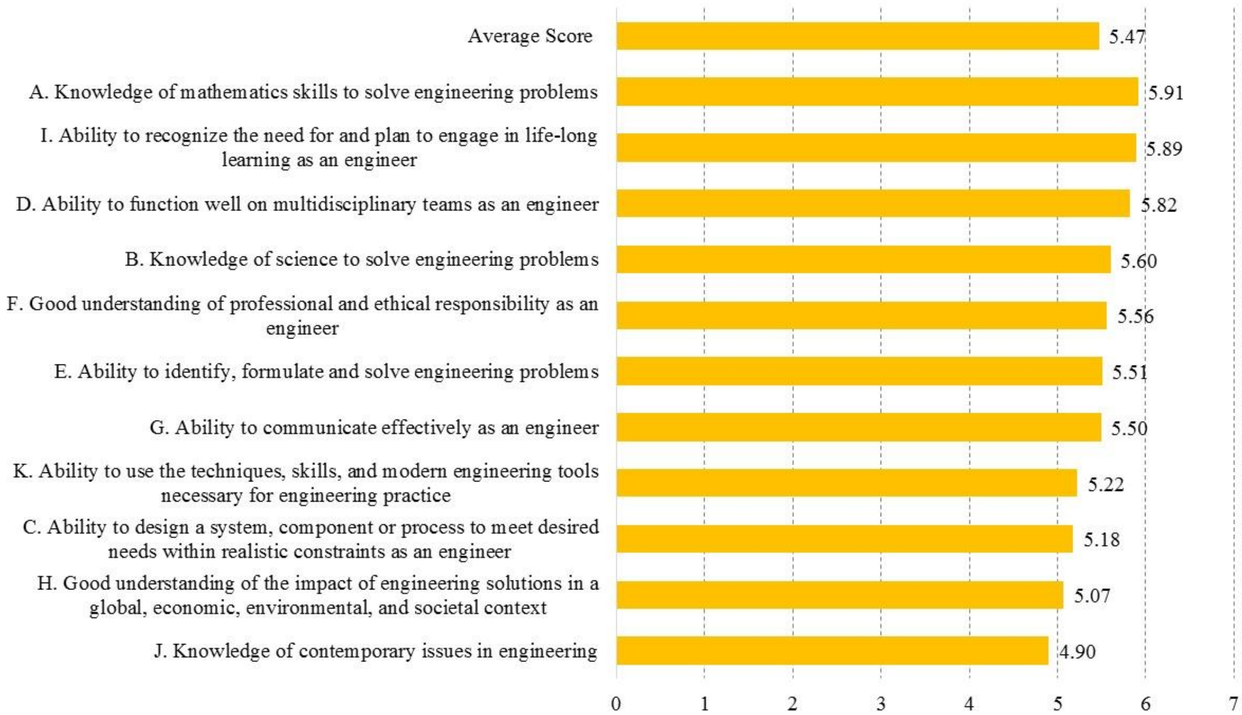

Figure 1. Students' Perceptions of their Ability on the ABET Outcomes

The ABET Engineering Student Outcomes about which the students reported to be most confident were outcomes, A, I, and D. Those outcomes received the highest average scores from the respondents of 5.91, 5.89 and 5.82 respectively. Those specific three survey questions in descending order beginning with the one receiving the highest average score are shown in Table 3.

Table 3. Students' Perception of their Ability on the ABET Outcomes with the Highest Scores

A.	I have the ability to apply my knowledge of mathematics to solve engineering problems.
I.	I recognize the need for and plan to engage in life-long learning as an engineer.
D.	I have the ability to function well on multidisciplinary teams as an engineer.

The ABET Engineering Student Outcomes about which the students reported to be least confident were outcomes, J, H, and C. Those outcomes received the lowest average scores from the respondents of 4.90, 5.07 and 5.18 respectively. Those specific three survey questions in ascending order beginning with the one receiving the lowest average score are the following.

Table 4. Students' Perception of their Ability on the ABET Outcomes with the Lowest Scores

J.	I have knowledge of contemporary issues in engineering.
H.	I have the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context.
C.	I have the ability to design a system, component or process to meet desired needs within realistic constraints as an engineer.

B. Gender Differences

There were some differences based on subgroup categories. The mean score for all female students (M = 5.16, SD = 1.08) was lower than the mean for the male students (M = 5.56, SD = 0.76) and the mean difference was statistically significant, $t(185) = 2.70$, $p = .008$ according to an independent samples t-test. As shown in Figure 2, when analyzing the gender subgroups apart from the overall group results, there were slight differences in which student outcomes ranked the highest and lowest. For the female students, student outcomes, I, D, and A ranked the highest and student outcomes, H, K, and C ranked the lowest. For the male students, student outcomes, A, D, and I ranked the highest and student outcomes, J, H, and C ranked the lowest. The lowest student outcomes recorded for the male students corresponded directly with the lowest overall rankings for the entire group of participants as male students were the majority.

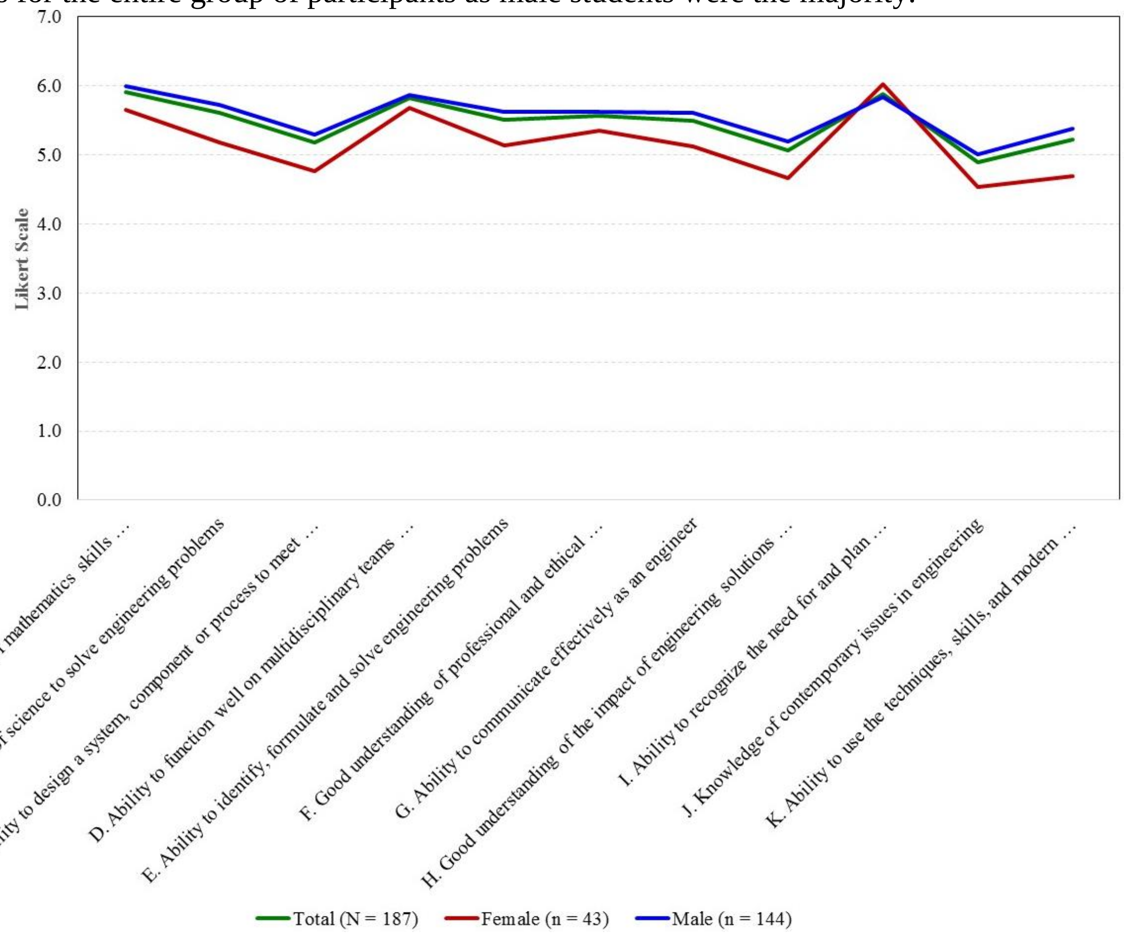

Figure 2. Students' scores on the eleven ABET Engineering Student Outcomes by gender

Table 5 shows results from independent samples t-tests for all items to determine if any of the gender differences were significant. Among the 11 items, four items, B, C, E, and K, showed significant gender differences in students' perceptions of their ability. Male students scored themselves higher than female students on the four items. While female students scored higher than male students on the item, I, the difference was not statistically significant.

Table 5. Gender Differences in Student Responses on Their Perceptions of the Ability for the ABET Outcomes and Final Grades on the Engineering Foundation Course

ABET Engineering Student Outcomes	Female		Male		*t*	*df*	*p*
	M	*SD*	*M*	*SD*			
A. Knowledge of mathematics skills to solve engineering problems	5.65	1.15	5.99	1.14	-1.72	185	.086
B. Knowledge of science to solve engineering problems	5.19	1.20	5.73	1.14	-2.72	185	.007
C. Ability to design a system, component or process to meet desired needs within realistic constraints as an engineer	4.77	1.54	5.30	1.15	-2.09	56.6	.041
D. Ability to function well on multidisciplinary teams as an engineer	5.67	1.43	5.87	1.10	-0.94	185	.348
E. Ability to identify, formulate and solve engineering problems	5.14	1.36	5.62	1.00	-2.15	56.2	.036
F. Good understanding of professional and ethical responsibility as an engineer	5.35	1.63	5.63	1.32	-1.14	185	.257
G. Ability to communicate effectively as an engineer	5.12	1.75	5.61	1.30	-1.72	56.4	.091
H. Good understanding of the impact of engineering solutions in a global, economic, environmental, and societal context	4.67	1.70	5.19	1.26	-1.82	57.7	.073
I. Ability to recognize the need for and plan to engage in life-long learning as an engineer	6.02	1.42	5.85	1.32	0.81	185	.419
J. Knowledge of contemporary issues in engineering	4.53	1.68	5.01	1.31	-1.70	56.8	.094
K. Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	4.70	1.51	5.38	1.20	-2.89	185	.004
Average Score	5.16	1.08	5.56	0.76	-2.70	185	.008
Final Grade	2.98	1.10	3.11	1.04	-0.73	185	.464

While male participants seemed to earn a higher grade in the engineering foundation course compared to their female counterparts, the mean difference by gender was not statistically significant. However, gender was significantly correlated with several items on students' perceptions of their ability on the ABET outcomes (i.e., B, C, E, G, H, J, and K) as shown in Table 6 and students' final grades scaled from 0 (D, F, and W grades) to 4 points (A grade) were also significantly correlated with several survey items (i.e., A, B, and I).

Table 6. Correlations of Students' Perceptions of their Ability on the ABET Outcomes with Gender and their Final Grade of the Engineering Foundation Course

	Final Grade	A	B	C	D	E	F	G	H	I	J	K	Average Score
Gender	0.054	.126	**.196***	**.177***	.069	**.183***	.083	**.147***	**.152***	-.059	**.145***	**.208***	**.195***
Final Grade	1.000	**.282***	**.205***	.135	.072	.141	.006	-.002	.025	**.199***	-.057	.046	.133

Note. $^*p < .05$

C. Differences between Majority (White) and Minority (Non-White)

The same analysis was completed to investigate any potential differences based on race and ethnicity. Subgroups for this analysis were categorized as Majority (White) and Minority (non-White). Table 7 shows results from independent samples *t*-test on students' scores on the 11 items. None of the correlations of minority status with students' scores on the 11 items were significant.

Table 7. Differences between Majority and Minority in Student Responses on Their Perceptions of the Ability for the ABET Outcomes and Final Grades on the Engineering Foundation Course

ABET Engineering Student Outcomes	Majority (n = 98)		Minority (n = 75)				
	M	*SD*	*M*	*SD*	*t*	*df*	*p*
A. Knowledge of mathematics skills to solve engineering problems	5.93	1.12	5.87	1.21	0.35	171	.729
B. Knowledge of science to solve engineering problems	5.63	1.16	5.56	1.20	0.40	171	.688
C. Ability to design a system, component or process to meet desired needs within realistic constraints as an engineer	5.24	1.24	5.16	1.32	0.44	171	.664
D. Ability to function well on multidisciplinary teams as an engineer	5.80	1.27	5.85	1.11	-0.31	171	.756
E. Ability to identify, formulate and solve engineering problems	5.58	1.00	5.45	1.15	0.78	171	.436
F. Good understanding of professional and ethical responsibility as an engineer	5.55	1.42	5.71	1.27	-0.75	171	.455
G. Ability to communicate effectively as an engineer	5.41	1.45	5.65	1.40	-1.12	171	.265
H. Good understanding of the impact of engineering solutions in a global, economic, environmental, and societal context	5.02	1.48	5.23	1.28	-0.96	171	.337
I. Ability to recognize the need for and plan to engage in life-long learning as an engineer	5.86	1.33	5.93	1.14	-0.40	171	.692
J. Knowledge of contemporary issues in engineering	4.76	1.38	5.16	1.29	-1.97	171	.051
K. Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	5.29	1.32	5.20	1.50	0.40	171	.690
Average Score	5.46	0.86	5.52	0.82	-0.50	171	.618
Final Grade	3.16	1.10	2.95	0.11	1.34	171	.179

VI. Findings and Future Work

In analyzing the data for this study from the students participating in the engineering foundation course, there were some significant outcomes discovered. The research revealed statistically significant gender differences in four items below. Males scored themselves higher than female students on the following four items (B, C, E, and K), signifying that the male students' perception of their ability is higher for these four factors.

B. Knowledge of science to solve engineering problems
C. Ability to design a system, component or process to meet desired needs within realistic constraints as an engineer
E. Ability to identify, formulate and solve engineering problems
K. Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

However, there were no significant differences in students' perceptions of their current ability on the ABET outcomes between majority (White) and minority (Non-White) students. These findings will be revisited after the students complete the second semester of their FYE curriculum. Further analysis will also be conducted on additional subgroups throughout the two years of this funded research. The faculty are hoping with this research to better inform the literature and practice with their findings.

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References

Besterfield-Sacre, M. E., Atman, C. J., & Shuman, L. J. (1997). Characteristics of freshman engineering students: Models for determining student attrition in engineering. *Journal of Engineering Education, 86*(2), 139–149. doi: 10.1002/j.2168-9830.1997.tb00277.x

Besterfield-Sacre, M. E., Moreno, M., Shuman, L. J., & Atman, C. J. (2001). Gender and ethnicity differences in freshmen engineering student attitudes: A cross-institutional study. *Journal of Engineering Education, 90*(4), 477–489. doi: 10.1002/j.2168-9830.2001.tb00629.x

CEB Inc. (2014). Most in-demand engineers around the world. Retrieved from http://www.cebglobal.com/talent-management/talent-neuron/resources/engineers-around-world.html

Engineering Accreditation Commission (2015). *Criteria for accrediting engineering programs: Effective for reviews during the 2016-2017 accreditation cycle*. Baltimore, MD: ABET

Fantz, T. D., Siller, T.J., & DeMiranda, M. A. (2011). Pre-collegiate factors influencing the self-efficacy of engineering students. *Journal of Engineering Education, 100*(3), 604-623. doi: 10.1002/j.2168-9830.2011.tb00028.x

Field, A. (2009). *Discovering Statistics Using SPSS*. 3rd Ed. London: SAGE Publications Ltd.

Freeman, R. B. (2005). Does globalization of the scientific/engineering workforce threaten U.S. economic leadership? National Bureau of Economic Research. Retrieved from http://www.nber.org/papers/w11457

Hutchinson, M. A., Follman, D. K., Sumpter, M., & Bodner, G. M. (2006). Factors influencing the self-efficacy beliefs of first-year engineering students. *Journal of Engineering Education*, *95*(1), 39-47. doi: 10.1002/j.2168-9830.2006.tb00876.x

Marra, R. M. (2006). Women Engineering Students' Self Efficacy – A longitudinal multi-institution study. Paper presented at the WEPAN Conference.

Mendoza Diaz, N. V., Richard, J., Wickliff, T., & Yoon, S. Y. (2017). Exploring enculturation in the first-year engineering program. *Proceedings of the 124th American Society for Engineering Education (ASEE) Annual Conference and Exposition, Columbus, OH, USA.*

Richard, J. C., Mendoza Diaz, N. V., Wickliff, T. D., & Yoon, S. Y. (2016). Enculturation of diverse students to the engineering practices through first-year engineering college experiences. *Proceedings of the 123rd American Society for Engineering Education (ASEE) Annual Conference and Exposition, New Orleans, LA, USA.*

Richard, J. C., Yoon, S. Y., Mendoza Diaz, N. V., & Wickliff, T. (2017). Enculturation of diverse students to the engineering practices through first year engineering experiences. *Proceedings of the 124th American Society for Engineering Education (ASEE) Annual Conference and Exposition, Columbus, OH, USA.* doi: 10.18260/p.26956

Stump, G. S., Hilpert, J. C., Husman, J., Chung, W., & Kim, W. (2011). Collaborative learning in engineering students: Gender and achievement. *Research Journal for Engineering Educatiuon*, *100*(3), 475-497.

Zhang, G., Anderson, T., Ohland, M. W., & Thorndyke, B. R. (2004). Identifying factors influencing engineering students graduation: A longitudinal and cross-institutional study. *Journal of Engineering Education*, *93*(4), 313-320. doi: 10.1002/j.2168-9830.2004.tb00820.x