Exploring Enculturation in the First-Year Engineering Program (Year II)

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Dr. Mendoza Diaz is Instructional Assistant Professor at the Dwight College of Engineering at Texas A&M University. She obtained her Ph.D. from Texas A&M University in Educational Administration and Human Resource Development and worked as a Postdoctoral Researcher with the Institute for P-12 Engineering Research and Learning-INSPIRE at the School of Engineering Education-Purdue University. She was a recipient of the Apprentice Faculty Grant from the Educational Research Methods ASEE Division in 2009. She also has been an Electrical Engineering Professor for two Mexican universities. Dr. Mendoza is interested in Pre-college and College Engineering Readiness, Socioeconomically Disadvantaged Engineering Students, Latino Studies in Engineering and Computer Aided/Instructional Technology in Engineering.

Dr. So Yoon Yoon, Texas A&M University

So Yoon Yoon, Ph.D., is an assistant research scientist at Institute for Engineering Education and Innovation (IEEI) within the Texas A&M Engineering Experiment Station (TEES) and Texas A&M University. She received her Ph.D. and M.S.Ed.in Educational Psychology with the specialties in Gifted Education and Research Methods & Measurement, respectively from Purdue University. Her work centers on P-16 engineering education research, as a psychometrician, program evaluator, and institutional data analyst. She has authored/co-authored more than 40 peer-reviewed journal articles and conference proceedings and served as a reviewer of journals in engineering education, STEM education, and educational psychology, as well as an external evaluator and an advisory board member on several NSF-funded projects.

Dr. Jacques C. Richard, Texas A&M University

Dr. Richard got his Ph. D. at Rensselaer Polytechnic Institute, 1989 & a B. S. at Boston University, 1984. He was at NASA Glenn, 1989-1995, taught at Northwestern for Fall 1995, worked at Argonne National Lab, 1996-1997, Chicago State, 1997-2002. Dr. Richard is a Sr. Lecturer & Research Associate in Aerospace Engineering @ Texas A&M since 1/03. His research is focused on computational plasma modeling using spectral and lattice Boltzmann methods for studying plasma turbulence and plasma jets. His research has also included fluid physics and electric propulsion using Lattice-Boltzmann methods, spectral element methods, Weighted Essentially Non-Oscillatory (WENO), etc. Past research includes modeling single and multi-species plasma flows through ion thruster optics and the discharge cathode assembly; computer simulations of blood flow interacting with blood vessels; modeling ocean-air interaction; reacting flow systems; modeling jet engine turbomachinery going unstable at NASA for 6 years (received NASA Performance Cash awards). Dr. Richard is involved in many outreach activities: e.g., tutoring, mentoring, directing related grants (for example, a grant for an NSF REU site). Dr, Richard is active in professional societies (American Physical Society (APS), American Institute for Aeronautics and Astronautics (AIAA), etc.), ASEE, ASME. Dr. Richard has authored or co-authored about 25 technical articles (19 of which are refereed publications). Dr. Richard teaches courses ranging from first-year introductory engineering design, fluid mechanics, to space plasma propulsion.

Dr. Tanya Dugat Wickliff, Texas A&M University

Delivering significant results in pivotal roles such as Sr. Consultant to high-profile clients, Sr. Project Manager directing teams, and Executive Leader of initiatives and programs that boost organizational effectiveness and optimize operations have been hallmarks of Dr. Wickliff's career spanning more than 24 years with leaders in the oil & gas and semiconductor industries.

As an expert in the areas of Executive Leadership and Team Development, Strategy Design & Execution, Supply Chain Optimization, Change Management, System Integration and LEAN Process Improvement (technical and business), Dr. Wickliff is passionate about Organizational Wellness and the Holistic Wellness of individuals. She is also a professional Facilitator and Motivational Speaker.

Dr. Wickliff earned a PhD in Interdisciplinary Engineering from Texas A&M University where she combined Industrial Engineering and Organizational Development to conduct research in the area of talent management and organizational effectiveness. She also completed an executive MBA from the University of Texas-Dallas and a BS in mechanical engineering from the University of Houston. She is founder of a nationally recognized pre-college initiative program, FreshStart, which has served more than 2000 students since its inception.

Dr. Wickliff is blessed to work daily in the area of her passion – developing young professionals – in her role at Texas A&M University. She is a Professor of Engineering Practice. At Texas A&M University, she has taught Capstone Senior Design, Statics & Dynamics, Engineering Ethics, Engineering Leadership and Foundations of Engineering courses. 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. Dr. Wickliff was honored to write the forward for her youngest son's book, "Young And Driven" which chronicles his historical journey from youngest engineer in the nation at age 19 to youngest Harvard Law graduate at 22 and more. 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 Rev. Oscar Smith and her three sons – Jamar Dugat, Raymond Wickliff and Dr. Cortlan J. Wickliff, Esq. Her youngest son, she was able to hood at his PhD ceremony upon his graduation from her same PhD program at Texas A&M University.

Exploring Enculturation in the First-Year Engineering Program (Year II)

During the Fall of 2016, Spring of 2017 and Fall of 2017, first year students have been asked about their understanding of engineering culture and their process of enculturation to engineering. Approximately 800 students have answered online surveys and approximately 45 have participated in focus groups. This poster presents the results of the NSF funded project titled "Research Initiation: Exploring Enculturation of Engineering students in the First-Year Engineering Program" during its second year of progress.

Enculturation is defined as the process by which an individual learns the traditional content of a culture and assimilates its knowledge, practices and values. The research team's approach to the professional formation of engineers is through the notion of the first-year engineering experience viewed as an "enculturating process." The goals of this project are (a) to increase the number of engineers supplied to the labor force, and (b) to increase the participation of traditionally underrepresented groups to engineering. The research questions this project seeks to answer are:

1. How do foundational engineering courses facilitate enculturation of first-year engineering students in terms of their performance in engineering enculturation outcome factors?

2. Among the engineering enculturation outcome factors, which are perceived by students to be the easiest and/or most challenging/difficult to achieve?

3. How do students' perceptions of enculturation to be an engineer change over time?

This poster presents results of two different studies that seek to answer the project's research questions. Both studies operationalize the enculturation in terms of ABET outcomes as indicators of enculturation factors.

A. Study 1

During the 2016-2017 school year, 685 (18.7%) out of 3,668 students who were taking two consecutive first-year engineering foundation courses attempted to respond to at least one of four online Qualtrics surveys (pre, 1st post, 2nd post, & 3rd post) on students' perceptions of engineering enculturation. Among them, during the 2016-2017 school year, in total, 662 students responded to one of the surveys and identified the easiest and the most difficult engineering enculturation outcome factors over time.

Table 1 presents the demographic information of participants and figures 1-4 present perceptions for all participants and for males and females from easiest to most challenging engineering enculturation outcome factors.

Table 1. Demographics of the participants in Study 1

		Fall 2016 Pre-survey		Spring 2017 Pre-survey		Spring 2017 Post-survey		Total	
Category	Subgroup	*n*	%	*n*	%	*n*	%	*n*	%
Gender	Female	73	26.6	102	28.3	31	32.6	183	27.6
	Male	201	73.4	258	71.7	64	67.4	479	72.4
Race/ Ethnicity[a]	Hispanic	77	28.1	84	23.3	17	17.9	157	23.7
	Asian	27	9.9	30	8.3	12	12.6	63	9.5
	AI/AN	0	0.0	1	0.3	0	0.0	1	0.2
	Black	9	3.3	10	2.8	0	0.0	19	2.9
	White	139	50.7	206	57.2	58	61.1	369	55.7
	Multiracial	8	2.9	10	2.8	6	6.3	21	3.2
Minority Status	Minority (non-White)	121	44.2	135	37.5	35	36.8	261	39.4
	Majority (White)	139	50.7	206	57.2	58	61.1	369	55.7
Residence	Domestic	260	94.9	341	94.7	93	97.9	630	95.2
	International	14	5.1	19	5.3	2	2.1	32	4.8
Student Level	First Year	232	84.7	328	91.1	89	93.7	592	89.4
	Upper Level	42	15.3	32	8.9	6	6.3	70	10.6
Campus	Main	249	90.9	324	90.0	77	81.1	590	89.1
	Branches/Academies	25	9.1	36	10.0	18	18.9	72	10.9
Total		274	100.0	360	100.0	95	100.0	662	100.0

Note. [a]Race/Ethnicity was categorized for domestic students only; AI/AN = American Indian or Alaska Native

A.1 Study 1 Results (overall participants)

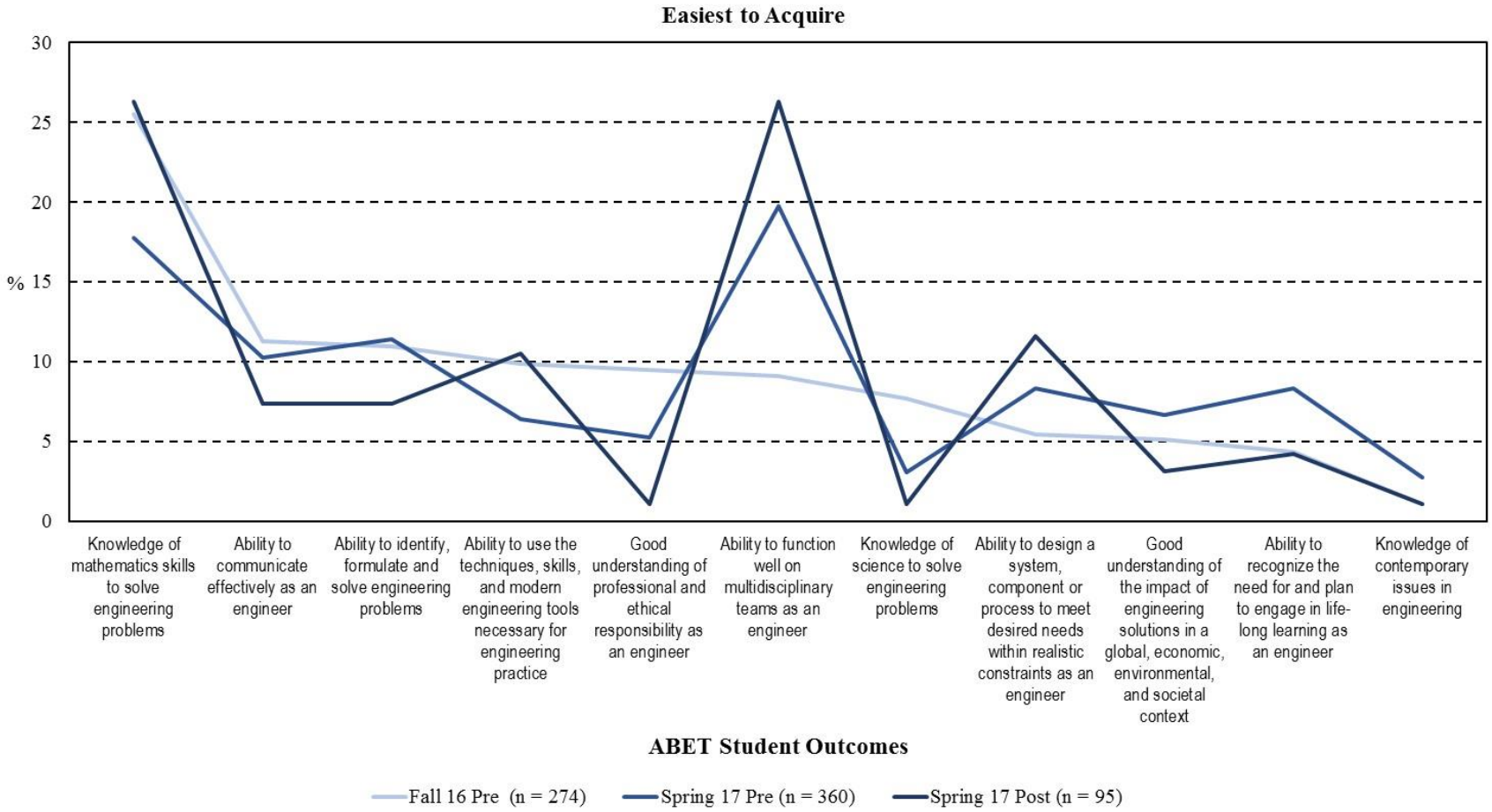

Figure 1. Changes of student perceptions of the easiest ABET student outcomes to acquire over time

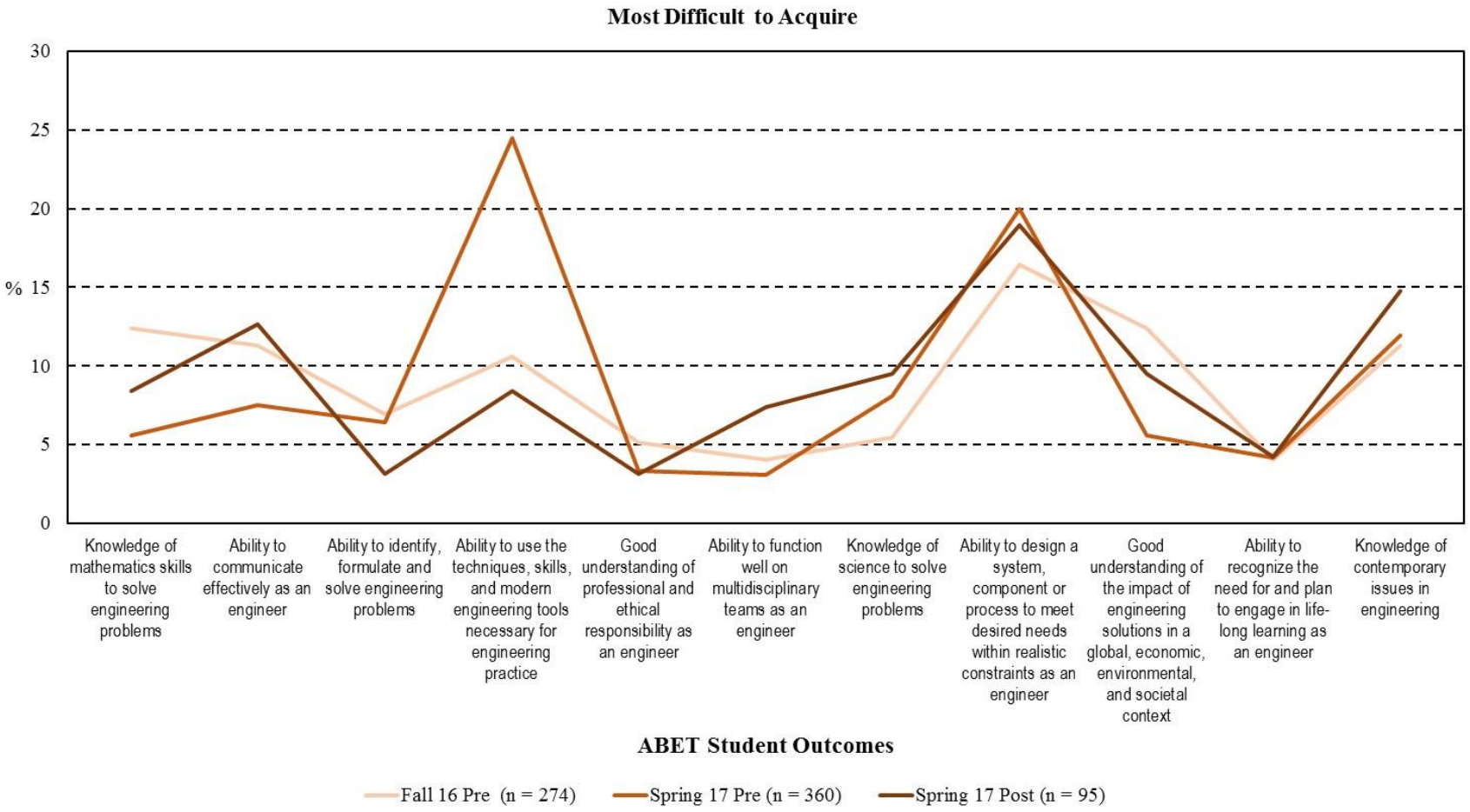

Figure 2. Changes of student perceptions of the most difficult ABET student outcomes to acquire over time

A.2 Study 1 Results (participants by gender)

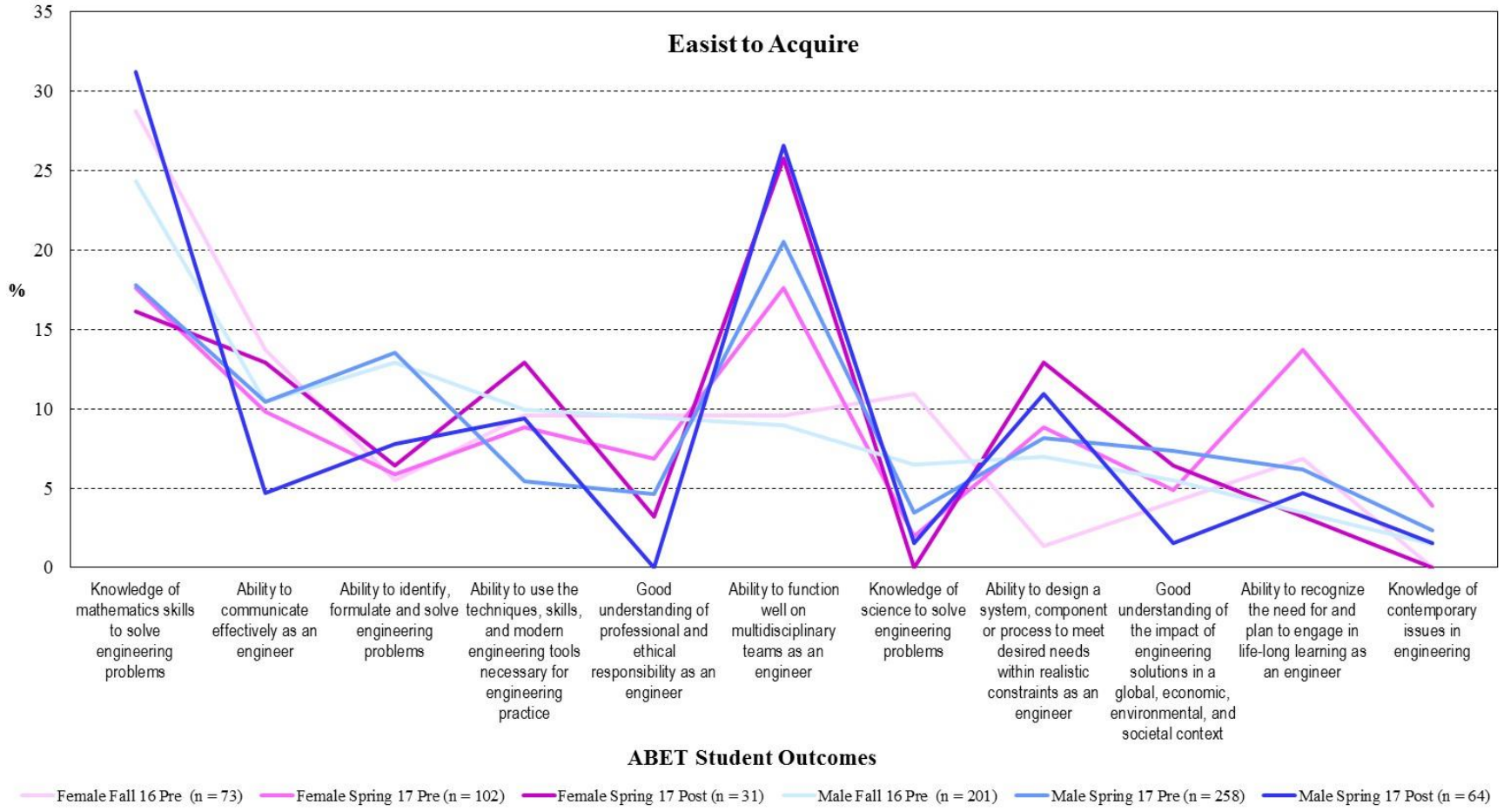

Figure 3. Changes of student perceptions of the easiest ABET student outcomes to acquire over time by gender

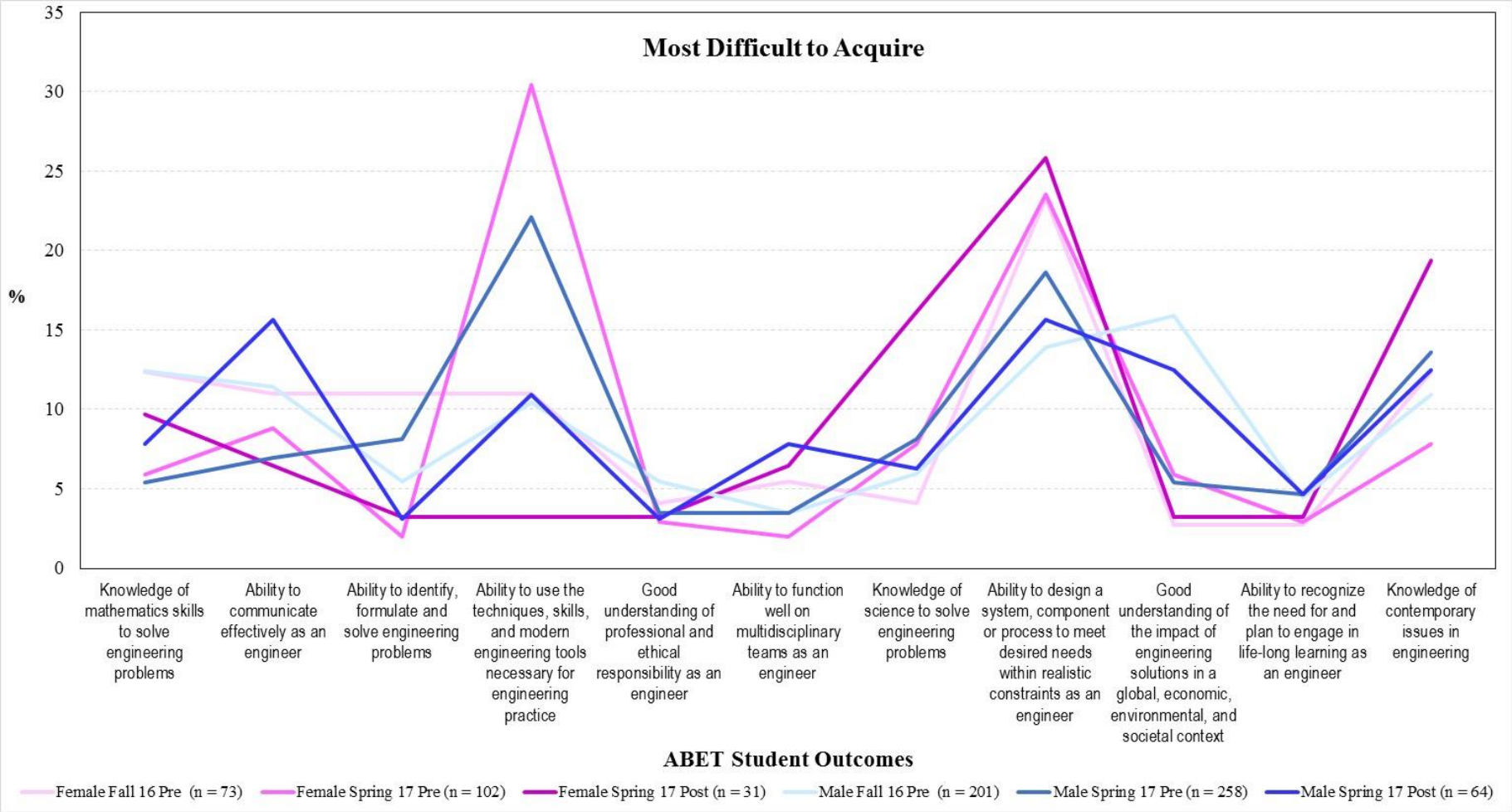

Figure 4. Changes of student perceptions of the most difficult ABET student outcomes to acquire over time by gender

B. Study 2

The three open-ended questions from a pre and post-survey (the focus of this study) seek the students' views of how the engineering enculturation is occurring while they are in the course. The questions guiding this study are:

1. What is the contribution of the engineering foundation course in developing students' successful engineering knowledge, practices, and values during the semester?
2. What factors other than the course contribute to developing students' successful engineering knowledge, practices, and values during the semester?

While 767 students elected to participate in the survey, 611 students completed their responses to the three open-ended questions of at least one of the pre-post surveys. Table 2 presents the demographic composition of the survey participants who responded to the pre-, post- and both pre-post surveys.

Table 2. Demographics of the Participants for Pre-Post Surveys

		Total		Pre-survey		Post-survey		Both	
Category	Subgroup	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
Gender	Female	164	26.8	102	26.9	83	26.4	21	25.6
	Male	447	73.2	277	73.1	231	73.6	61	74.4
Race/ Ethnicity[a]	Hispanic	145	23.7	86	22.7	76	24.2	17	20.7
	Asian	96	15.7	65	17.2	45	14.3	14	17.1
	AI/AN	1	0.2	1	0.3	1	0.3	1	1.2
	Black	13	2.1	10	2.6	4	1.3	1	1.2
	NAOP	2	0.3	2	0.5	1	0.3	1	1.2
	White	319	52.2	193	50.9	168	53.5	42	51.2
	Multiracial	16	2.6	10	2.6	9	2.9	3	3.7
Minority Status	Minority (non-White)	273	44.7	174	45.9	136	43.3	37	45.1
	Majority (White)	319	52.2	193	50.9	168	53.5	42	51.2
Residence	Domestic	592	96.9	12	3.2	304	96.8	79	96.3
	International	19	3.1	367	96.8	10	3.2	3	3.7
Student Level	First Year	589	96.4	365	96.3	306	97.5	82	100.0
	Upper Level	22	3.6	14	3.7	8	2.5	0	0.0
Campus	Main	443	72.5	276	72.8	229	72.9	62	75.6
	Branches/Academies	168	27.5	103	27.2	85	27.1	20	24.4
Total		611	100.0	379	100.0	314	100.0	82	100.0

Note. [a]Race/Ethnicity was categorized for domestic students only; AIAN = American Indian or Alaska Native; NAOP = Native Hawaiian or Other Pacific Islander

Figure 5 presents 14 prominent themes that came from student responses assessed both at the beginning and end of the first semester engineering foundation course, and the contributions of the course on their enculturation. While most of the emerged themes were well-aligned with one of the eleven ABET Student Outcomes, new themes also emerged.

At the end of the semester, there was a significant drop in students' perceptions about the values of engineering culture/engineer (from 35.4% to 23.2%). However, more students acknowledged the contribution of the course to their algorithmic thinking (through the use of MATLAB and LABVIEW to analyze and interpret data). Overall, similar percentages of responses on the majority of themes across both pre- and post surveys indicate that the foundation course actually met student expectations about the process of enculturation to engineering and learning about the course topics aligned with the ABET Student Outcomes.

Figure 6 shows changes in all students' views of outside factors (outside to the first year engineering course) from expected to contribute to their final acknowledged contributions by the end of the semester. Other classes (mostly math and science) dominated the conversation and remarkably did not change. The impact of professional societies or extra-curricular clubs increased. The greatest increase is in the impact of other people (family, friends, peers, upper-class students, even professors or a few practicing engineers), presumably as students developed more relationships. Teamwork and communication dropped slightly but still relationships seemed to matter more, over time, than just acquiring knowledge and skills.

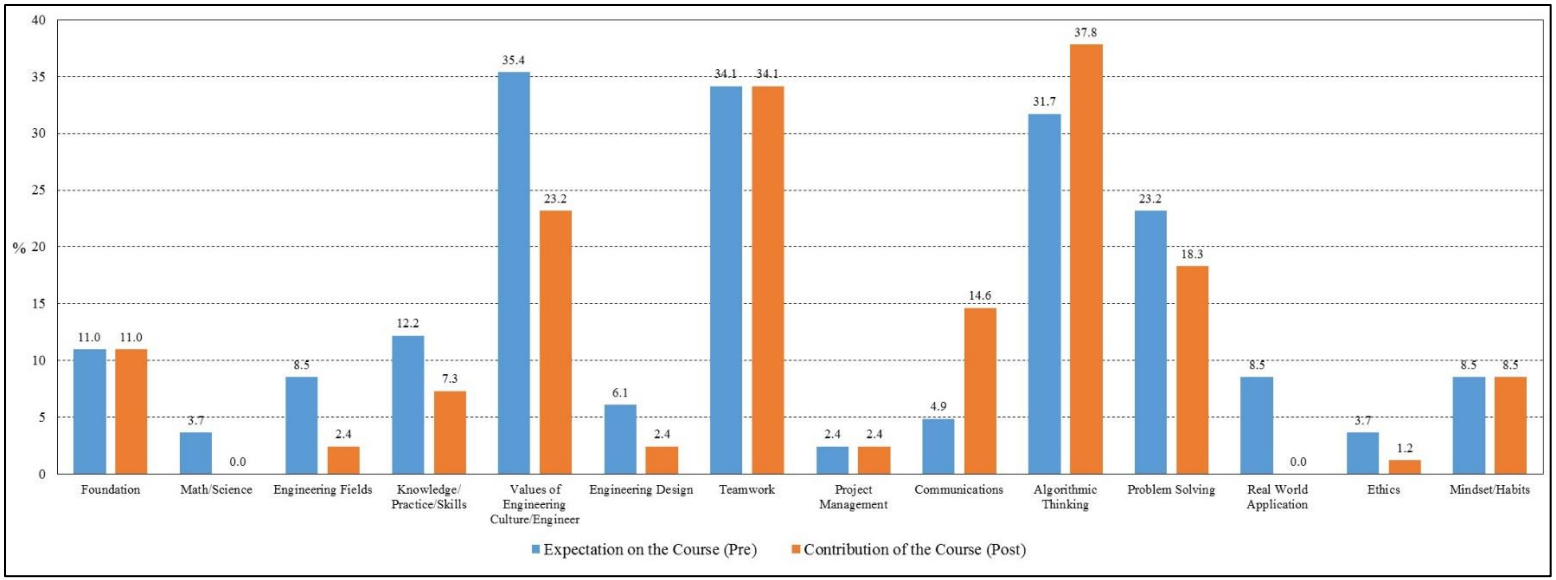

Figure 5. Student expectations (pre) on and contributions (post) of engineering foundation course in their engineering enculturation

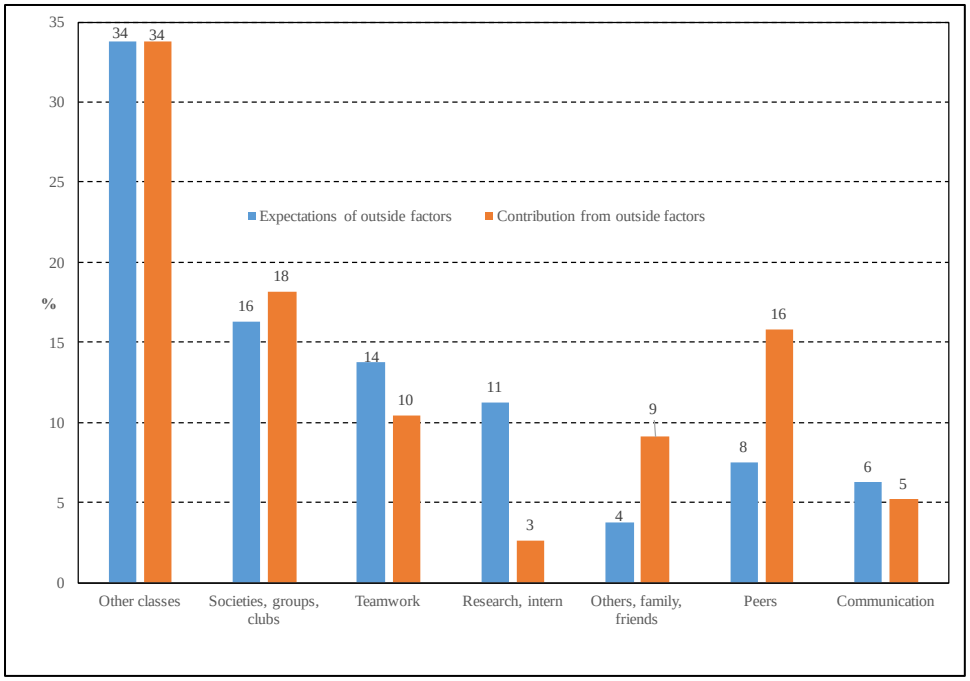

Figure 6. Change in other factors outside of the course that impact student engineering enculturation over time from expected (pre) to what contributed (post).

Discussion and Results

In terms of rating ABET outcomes (considered enculturation factors), from easiest to more challenging, the analysis revealed that the outcomes perceived as more challenging are: (a) the ability to design a system, component or process to meet desired needs within realistic constraints as an engineer, (b) knowledge of contemporary issues in engineering, (c) ability to communicate effectively as an engineer. The easiest perceived outcomes were (a) the ability to function well on multidisciplinary teams as an engineer, (b) the ability to apply my knowledge of mathematics to solve engineering problems, (c) the ability to use the techniques, skills, and modern tools necessary for engineering practice.

Also, an important and major implication of the results is that students come into the course looking to acquire skills, as many first-year students indicated, regardless of gender or ethnicity. The growth in importance of other people to the students in the course suggest that they have moved toward a key step in the transformation and evolution in that they have recognized the importance of more than just acquiring new skills, but building a broader network in their engineering culture. Interesting that upper-level students have indeed *learned* to include learning in the definition of enculturation and also that learning and networking is part of cultural development. This change from the first-year to mid-year could also represent the aforementioned transformation and evolution, in this case, of the engineering student throughout the undergraduate years

In general terms, the implications of these results are that gender, ethnicity, and level in the engineering program play a role in the way enculturation to engineering is perceived and assimilated during the first-year engineering experience. Further investigation is taking place as part of the ongoing, second year of this project.