The Impact of Near-Peer Mentoring on Self-Efficacy in an Introductory Engineering Course

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***Abstract* — This work-in-progress considers the integration of junior and senior engineering students as near-peer mentors in a first-year Introduction to Engineering course at Florida Gulf Coast University. A primary purpose of incorporating mentors into the class is to allow first year students to more easily find their fit within the college and promote increased retention in engineering. The social validity (participants' perceived value) of the program is evaluated through a mixed method approach including the use of pre- and post-course surveys of the students enrolled in the course and focus group discussions with the students serving as near-peer mentors. The impact of these relationships on student self-efficacy and the future direction of the program will also be included.**

Keywords—near-peer mentors; first-year retention; classroom mentoring; self-efficacy

I. Background and Significance

While engineering job growth continues to remain steady or increase, the lack of qualified individuals to fill these positions, particularly under-represented populations, remains a concern. Although under-represented minority (URM) groups represent 28.5% of our nation's overall population (2006), they comprise only 9.1% of college-education Americans in science and engineering occupations [1]. This underrepresentation is not due to a lack of interest amongst URM groups, but is due to poor degree completion rates [2]. One methodology researchers have examined to reduce or reverse poor retention rates is the use of near-peer or like-peer mentoring. It has been shown that amongst African-American engineering students at Auburn University, acting as a near-peer mentor aided in the mentor's academic growth and was suggested to be a promising prospect for student retention [3]. Similarly in a bridge program (programs designed for high school students transitioning into college engineering programs) at Tennessee Tech, African-American mentees demonstrated similar gains [4]. Researchers have shown similar results in populations of women engineers [5, 6] as well as research focused on first-year graduate students [7].

Kuh *et al.* have also demonstrated through a regression analysis of multiple engineering programs that the educationally purposeful activities described in the National Survey of Student Engagement, including tutoring, discussing ideas from readings or classes with others outside of the classroom, and having serious discussions with students of different racial, ethnic, or ideological backgrounds produced a statistically significant increase in first year grades, and second year persistence [8]. A recent review of mentoring programs [9] suggests that more rigorous research should be completed, particularly with respect to the assessment of the social validity (participants perceived value) of the programs. This program will specifically examine the impact near-peer mentors have on cultivating a sense of belonging within engineering, and whether or not this contributes to confidence in degree completion and retention in the engineering programs.

II. Project Objectives and Focus

The specific objectives of this multi-year project are to:

1. Increase self-efficacy of engineering students engaged in near-peer mentoring.
2. Evaluate the impact of mentor (TA) training on effectiveness and self-efficacy.
3. Evaluate the impact of near-peer mentoring on first-year retention in engineering.

The focus of this paper is on results from the first semester of implementation of objective 1. Limited mentor (TA) training, objective 2, was included prior to the first year of program implementation in order to obtain a control before the commencement of formal training scheduled for the summer of 2016. Preliminary results for objective 3 based on student feedback will be included, with further plans for longitudinal tracking of TA participants throughout program implementation.

III. Course Description

EGS 1006L – Introduction to the Engineering Profession is a 1-credit hour course required of all Environmental, Civil, and Bioengineering majors in the U. A. Whitaker College of Engineering at Florida Gulf Coast University. The fall 2015 semester included 3 sections of the course taught during the same 75-minute time period with a total enrollment of 105 students. The simultaneous offering of the course allowed instructors to break students into different groups independent of the section for which they registered, and also allowed for having all students meet as a single section. This single large section was beneficial for guest speakers and panel presentations, while dividing the class into smaller sections

facilitated a better environment for team meetings and comprised the bulk of the semester.

The primary deliverable for the course is a team-based semester research project (SRP) focusing on a current innovation of the group's choosing and includes a group final paper (25% of the course grade) and an individual presentation and handout (15% of the course grade). Throughout the semester interim deliverables, both individual and group, are expected on a weekly basis and align with pieces of the final paper, presentation, and / or handout. Class time begins with a 10 – 15 minute introduction and large class discussion of the weekly topic and then transitions into team-based discussions and assignment completion [10].

In addition to serving as an introduction to engineering, the course also aligns with the University's Quality Enhancement Plan focused on critical thinking, writing, and information literacy. As a lower level course in the curriculum, EGS 1006L provides an excellent opportunity to assess baseline levels of student skills in these three areas, as well as the chance to introduce important resources (e.g. library, writing center, center for academic achievement, etc.) to assist students in strengthening their information literacy, writing, and critical thinking skills.

A. Including Mentors in the Course

Mentors (TAs) were introduced to the course for the first time in the fall 2015 semester. These students are upperclassman in each of the three different engineering majors who are present both in person during class, as well as online in the Learning Management System (LMS). During class time mentors engage with the various student groups, asking and answering questions, providing clarification, challenging preconceived notions, and offering support. From a logistics perspective the goal is for each student group to have interaction with at least two mentors (TAs) or instructors each class period. Multiple mentors provide students enrolled in the course with a diverse perspective and the opportunity to hopefully more closely identify with an upperclassman.

Outside of class, mentors are assigned specific groups to which they provide feedback for course deliverables. This assignment provides continuity throughout the course ensuring that comments or points requiring additional clarity are addressed in subsequent submissions. Assignments are based on mentor interest in team topics, with mentors being responsible for anywhere between 2 – 4 teams (depending on class size and number of mentors). In addition to providing feedback for these group assignments, mentors also provide feedback on individual submissions as well. In the fall semester mentors were assigned submissions that correlated with the individuals in their assigned groups, while in the spring, assignments rotated through all the mentors in the course with a single mentor being responsible for all student submissions for a given assignment.

B. Course Evaluation

Students enrolled in the course were invited to participate in pre- and post-course surveys that had been approved by the University's Institutional Review Board (IRB). Students were offered extra credit in the course for survey completion, with other opportunities available throughout the semester to earn the same level of extra credit if they chose not to complete the surveys. Surveys and all forms of extra credit were recorded by a faculty member from the College of Education, who provided course instructors with a list of extra credit points (not method earned) per student at the end of the semester.

Surveys were developed based on questions from both the Longitudinal Assessment of Engineering Self-Efficacy Survey and the Undergraduate Engineering Mentor and Mentee Surveys, both developed by Pennsylvania State University (PSU) and the University of Missouri (UM) [11].

IV. Results and Discussion

The pre- and post-course tests were administered to the students on the first class and last (or next to last) class of the semester. While both the pre-test and post-test focused on self-efficacy and student success within engineering, the post-test also contained additional questions focused on the quality and efficacy of the student mentors (TAs) and their interactions with the classes. These tests were blinded, with a student ID assigned to each test to allow for pre-test to post-test comparisons. Supplementary information, including major and gender were collected to allow for additional analysis.

For this study, two factors were examined, specifically the student's confidence in continuing with engineering as a major, and the quality of their interactions with the class mentors (TAs). For the analysis, correlations between these two factors were drawn and statistical examination of the populations was conducted. Students that did not complete both the pre-test and post-test were excluded (n=8) from this analysis, as were any students who switched majors during the course of the semester to something other than engineering (n=5). As such, all analysis was conducted on n=83 students who took the class in fall 2015.

A. Engineering Confidence

In both the pre-test and post-test, students were asked how confident they were in continuing with engineering as a major. Here, we wanted to see how well they thought engineering was a good fit for them as a major, as well as gain an understanding as to how much students thought they would have success in engineering. The survey instrument used a five-point scale ranging from not at all confident, to very confident, with intervals of fairly confident, 50% chance of change and not very confident in-between. As demonstrated in Table 1, 24% of the students had their confidence increase by one or more Likert scale point over the course of the semester (n=20, denoted by green cells) compared to 15.6% of the students whose confidence decreased by one or more Likert point over the semester (n=13, denoted by red cells). Although this result in and of itself does not suggest that an increase in self-confidence directly resulted from the course offering, it does suggest that some students gained a better sense of place within engineering over the course of the semester. This sentiment was echoed across multiple questions within the survey, as shown in Figure 1, where a majority of the students surveyed stated that they have many friends who were studying

engineering, and that this was important to them. From the data, it is evident that over 90% of our students were "very confident" (50.6%, n=42) or "fairly confident" (43.4%, n=36) in their ability to continue within engineering.

Table I. MATRIX OF PRE-COURSE TO POST-COURSE SURVEYS ASSESSING STUDENT CONFIDENCE IN CONTINUING WITH THEIR ENGINEERING MAJOR. COLUMNS REPRESENT THE NUMBER OF RESPONDENTS STATING THEY WERE "VERY CONFIDENT", "FAIRLY CONFIDENT", "50% CHANCE OF CHANGE", "NOT VERY CONFIDENT" OR "NOT AT ALL CONFIDENT" FOR THE PRE-COURSE SURVEY. ROWS REPRESENT THE SAME RESPONSES FOR THE POST-COURSE SURVEY. GREEN CELLS REPRESENT RESPONSES THAT INCREASED FROM PRE-TEST TO POST-TEST, WHILE RED CELLS REPRESENT RESPONSES THAT DECREASED FROM PRE-TEST TO POST-TEST.

		Pre-Test Survey				
		Very	***Fairly***	***50/50***	***Not Very***	***Not At All***
Post-Test Survey	***Very***	24	16	2	0	0
	Fairly	10	25	1	0	0
	50/50	1	1	1	0	1
	Not Very	0	1	0	0	0
	Not At All	0	0	0	0	0

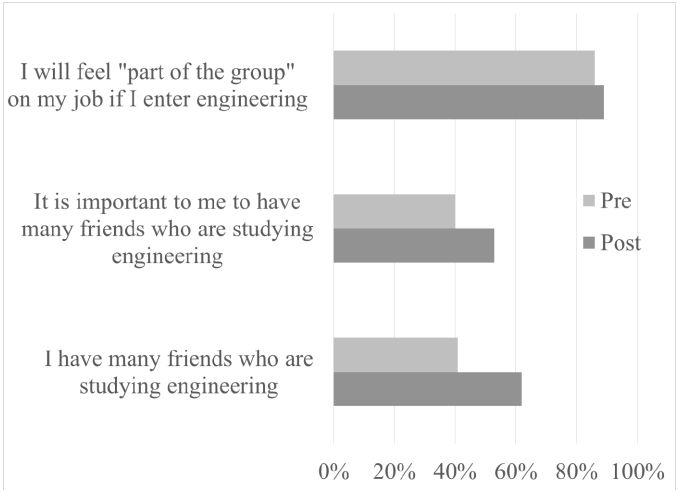

Fig. 1. Student responses to survey questions regarding sense of place in engineering. Data shows number of respondents who "agreed" or "strongly agreed" to the statements provided on the pre- or post-test. N=83 respondents.

B. Mentor (TA) Impact

To see what affect, if any, our TAs had on the "very confident" and "fairly confident" student cohorts, we compared the post-survey responses from these two cohorts regarding their perceptions of the course TAs. Four questions from the survey were examined, focusing on the quality of interactions the students had with their TAs. Those four questions looked at the TAs' ability to answer questions about the course, their ability to create an ongoing relationship, and the frequency and quality of interactions the students had with the TAs. Table 2 summarizes these responses amongst the two cohorts for these four questions, graded on a 4 point Likert scale ranging from "very dissatisfied" to "very satisfied". Students also had the option to answer "not applicable" if they had no opinion of the question. A summation of these results are included in Figure 2.

Table II. STUDENT POST-COURSE SURVEY RESPONSES TO THEIR INTERACTIONS WITH THE COURSE TAS. RESPONSES WERE GROUPED INTO STUDENT COHORTS THAT WERE EITHER "VERY CONFIDENT" OR "FAIRLY CONFIDENT" THAT THEY WOULD CONTINUE WITH ENGINEERING AS THEIR MAJOR. DATA IS DISPLAYED AS PERCENT OF THE TOTAL NUMBER WITHIN THE COHORT. N=42 IN THE "VERY CONFIDENT" COHORT AND 36 IN THE "FAIRLY CONFIDENT" COHORT.

	Very Satisfied	**Satisfied**	**Dissatisfied**	**Very Dissatisfied**	**N/A**
Ability to answer your questions about the EGS 1006L course / course assignments					
Highly Confident	52.4%	26.2%	7.1%	4.8%	9.5%
Fairly Confident	33.3%	58.3%	2.8%	5.6%	0.0%
Ability to create an ongoing relationship					
Highly Confident	40.5%	21.4%	11.9%	9.5%	16.7%
Fairly Confident	25.0%	44.4%	8.3%	5.6%	16.7%
The frequency of contact with the TAs					
Highly Confident	40.5%	28.6%	14.3%	7.1%	9.5%
Fairly Confident	20.0%	60.0%	5.7%	2.9%	11.4%
The quality of interactions with the TAs					
Highly Confident	39.0%	31.7%	14.6%	7.3%	7.3%
Fairly Confident	30.6%	58.3%	2.8%	2.8%	5.6%

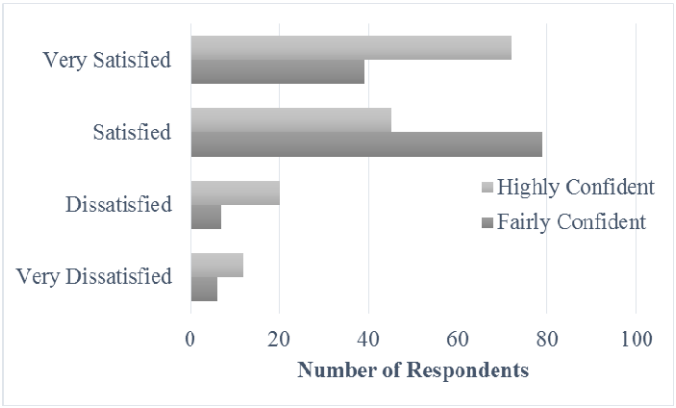

Fig. 2 Overall perception of student interactions with course TA. Data represents summed responses from the four questions described in Table 2.

As demonstrated by Table 2 and Figure 2, there are differences in the distribution of the Likert responses between the two cohorts. Those within the "very confident" cohort had a larger overall percentage of "very satisfied" responses compared to the "fairly confident" cohort (43.1%, n=72 responses vs. 21.1%, n=39 responses), however, a larger percentage of their responses were also "dissatisfied" or "very

dissatisfied" compared to the other cohort. This discrepancy was most noticeable in the questions regarding the frequency of contact and quality of interactions. Through the training workshop that will occur this summer, we hope to be able to address some of these concerns.

C. *Self-Reporting of Retention*

Of the 83 students who completed both pre and post surveys in the fall semester, 64 (77%) indicated that they were not currently exploring other majors. Of the 19 that did indicate they were looking at other majors; 10 (12%) indicated an engineering major not offered at the University, four (5%) listed a STEM major outside of engineering, and the remaining 5 were either not sure (3) or listed a non-STEM (2) major. More formalized retention data and analysis will be considered by looking at enrollment in subsequent courses for the next academic year.

V. Conclusion and Future Direction

The 2015 – 2016 academic year represented the first year of implementing mentors (TAs) into the introductory engineering course. Preliminary results suggest that students enrolled in the course were satisfied to very satisfied with the mentor interactions and course contributions. Students also demonstrated an increase in self-identifying belonging in engineering, both currently as well as in the future.

The next step of analysis is the integration of spring 2016 data with that of the fall 2015 data presented herein. Results of these two semesters will influence the programming of the Mentor / TA training workshop scheduled to be delivered in the summer of 2016 for the 2016 – 2017 academic year mentors. Additionally, evaluation of AY 2015 – 2016 EGS 1006L – Introduction to the Engineering Profession student enrollment into subsequent engineering courses will be compared to retention numbers from previous years.

Transcripts from mentor (TA) focus groups will be coded to identify recurring themes from the AY 2015 – 2016 mentor population. In addition to these results informing the training workshop schedule they will also serve as a starting point for recognizing ways in which mentoring impacts students serving in the mentor position.

Prior to the 2016 – 2017 academic year course offerings of EGS 1006L, both pre and post surveys will be analyzed to determine if changes are necessary to clarify / modify questions or add / remove questions to better address program objectives. Additionally, consideration is being given to the possibility of including focus group discussions with EGS 1006L students. The purpose of these discussion would be to more clearly identify if mentor integration into the course is a direct, indirect, or non-contributing factor to improved confidence levels.

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