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A Sense of Belonging: Creating a Community for First-generation, Under-represented groups and Minorities through an Engineering Student Success Course

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A Sense of Belonging:
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I. Introduction/Background

In engineering departments across the United States, there remain significant discrepancies in retention, performance, and satisfaction between students of underrepresented groups (first-generation, underrepresented minorities, women, and low socioeconomic status) and those of dominant groups (white, male) [21, 26]. To increase the population of underrepresented engineering students and to foster their success, targeted recruitment, academic services, and social support can be developed and refined. As the demand for engineers and related professions continues to grow, it is increasingly important that universities prioritize their efforts to recruit, retain, and sustain engineering students of diverse backgrounds and identities[19].

To better support first-generation and underrepresented minority (URM) students in engineering at a large polytechnic university, an introductory course, *Engineering Student Success* (ENGR 101), was specifically designed and offered during the fall quarter of the 2015-16 school year as a part of a NSF S-STEM grant, Program for Engineering Excellence for Partner Schools (PEEPS). PEEPS is a cohort scholarship program that provides engineering students with financial, academic, and social support[3]. ENGR 101 was developed by two engineering faculty, a VISTA member, and supported by a curriculum expert, to expand the benefits of PEEPS to a larger number of students and to establish interventions and practices in engineering classrooms that better support diversity on our university's campus. The specific course goals were to develop and enhance students' engineering identity and sense of belonging within the College of Engineering in order to support their academic and social transition to college. To achieve these goals, the course curriculum emphasized career exploration, collaboration with peers, written reflections, and diversity and global learning opportunities.

We identified with Yosso's theory of "navigational capital," which captures the knowledge and skills of underrepresented or underprivileged students that enable them to navigate institutions and communities where a dominant culture prevails [27]. Rather than taking a deficit approach (i.e. minority students need to be fixed), this study focuses on cultivating the strengths and assets of first-generation and URM students to guide them toward success in engineering. In addition to supporting these students, this course and study also seek to establish best practices that could be implemented more broadly in other introductory engineering courses. Therefore, the purpose of this paper is to explore a developmental approach to engineering success that allows introspection of the individual and building of community. Data were collected throughout the quarter in an attempt to answer the following research questions:

- What can we learn from an emphasis on intentional activities and reflective writing to help first-generation students develop an "engineering identity" and ownership over their engineering major?
- Does a course focused on relationship building, diversity, and social awareness improve first-generation students' sense of belonging within the College of Engineering?

The following sections of this paper highlight our journey. We begin with a brief rationale for offering an introductory engineering course specifically designed for first-generation and URM students. After the rationale, we provide details about the class and the methods of study including participants, data collection, and analysis. Next, we investigate the effectiveness of the course by analyzing written reflections and pre- and post-survey data. Throughout this project, we also include our observations, discussions, and experiences as an important part of our own reflection as educators on the process of the course and study. We conclude with suggestions for future iterations of the class and recommendations for fostering inclusive environments within engineering classrooms.

II. Rationale

Numerous studies have shown the benefits of diverse student populations and curricula in higher education[11, 5, 2]. Inside and outside the classroom, diversity enhances the college experiences for both minority and majority students. Simply interacting with students of a different ethnicity/race and engaging in discussions surrounding ethnicity/race was shown to positively influence students' level of intellectual and civic engagement[11]. Incorporating topics of diversity and implementing a diverse pedagogy in the classroom can expose students to new perspectives, challenge stereotypes and stimulate critical thinking[1, 5]. In effort to increase the diversity of university student populations, it is important for engineering departments to provide support for first-generation and underrepresented minority students during their transition to college. Along with support for these students, engineering departments need to design curricula and foster a department culture that embraces the differences and strengths that these students bring to the field of engineering.

First-generation students—students whose parents do not have four-year degrees—often bring ethnic, cultural, and socioeconomic diversity to university campuses. These students also tend to face additional academic and social challenges during their transition to college when compared to their peers with parents who graduated from college[4, 8, 25]. The challenge in retaining first-generation and underrepresented minority students in engineering is often tied to a limited sense of belonging within engineering departments and a lack of "engineering identity"[16, 17, 22]. A student's sense of belonging can be defined as a psychological sense of identification and affiliation with the campus community[12]. Students' academic performance and persistence in engineering can be attributed in part to how comfortable and satisfied they feel in their engineering program. It has been found that a lack of belonging within their major or department contributes to students' decisions to discontinue their engineering degree[17].

A study conducted by Jordan and Sorby (2014) showed that underrepresented minority students have a significantly lower sense of belonging compared to their majority student counterparts. They found that this lack of belonging can be attributed to feeling excluded from study groups and/or limited connection with faculty. Students' perceptions and interactions with other students, staff, and faculty can positively influence whether or not they cultivate a sense of belonging within their engineering major. The researchers also found that a sense of belonging can be increased by exposing students to opportunities within engineering to give back to their communities or to contribute to other social good efforts[15].

In addition to developing a sense of belonging, it is important for students to form their engineering identity, which can be defined as "a personal identification with the duties, responsibilities, and knowledge associated with a professional role" [7]. The path to becoming an engineer involves more than just gaining technical knowledge and skills; it involves the personal and social process of identifying with the profession. The development of an engineering identity is a challenge for many students because the field of engineering is typically associated with "things" (i.e. math, science, machines, technology) versus with actual people[20]. For URM and first-generation students developing an engineering identity is additionally challenging when the culture of engineering may clash with these students cultural, ethnic, gender, and/or socioeconomic identity.

Metacognition is often associated with exploring identity through providing the opportunity to engage in "thinking about (one's own) thinking" or "learning to learn" or "knowing about knowing." Fusco and Fountain (1992) suggest that metacognition "involves the monitoring and control of attitudes, such as students' beliefs about themselves, the value of persistence, the nature of work, and their personal responsibility in accomplishing a goal" (p. 240; cited in Kolencik & Hillwig, 2011, p. viii)[9]. Reflection is a metacognitive strategy that can be used to engage a learner in connecting prior knowledge to the current learning situation. It requires a student to explicitly make connections between ideas and experiences spread out over time to help in "recognizing the relevance"[23].

III. Research Focus

This goal of this study was to determine how an introductory engineering course affects first-generation and underrepresented students in regards to their sense of belonging and engineering identity. In this section, we provide details about the course and the participants in the study.

Course Description

ENGR 101 met once a week for two hours in the evening during Fall Quarter 2015. The course was a one unit, credit/no credit activity course that students could take in addition to a major specific engineering course that all students take their first year. The course was co-taught by three instructors: an engineering professor, an engineering academic advisor, and an AmeriCorps VISTA member. This was the second year that ENGR 101 was offered through the College of Engineering, so the curriculum for Fall 2015 was heavily influenced by feedback and observations from the previous year of this course offering. The three instructors collaboratively designed the curriculum the summer prior to the class. Table I shows a summary of the activities and topics that were included in each week:

Table 1. ENGR 101 Weekly Course Activities and Topics

Week	**Activity**
Week 1	Welcome and introductions; engineering design cycle team activity
Week 2	Engineering discipline presentation
Week 3	Industry career panel
Week 4	Global perspectives in engineering role playing activity, identity wheel activity
Week 5	Values affirmation activity, time management activity
Week 7	Current events and social issues research project and presentation
Week 8	STEM outreach training and volunteering
Week 9	Social entrepreneurship presentation
Week 10	Final class celebration and reflection

The curriculum incorporated collaborative learning activities and a variety of speakers to make the course interactive and engaging. Multiple class sessions were dedicated to exposing students to different types of engineering and career opportunities. In the beginning of the quarter, we presented students with information about all the engineering majors at our university. Students participated in team-building activities that prompted research into their engineering majors and career options. In Week 3, we organized an industry career panel with a diverse mix of recruiters and alumni that currently work as engineers. The students asked questions about the panel's past college experiences, internships, graduate school, and careers. Students also had the opportunity to practice their "60 second pitches" with the panel members to help prepare for a career fair.

Throughout the quarter, we incorporated activities that addressed global perspectives of engineering, current events, and social justice. In Week 4, we collaborated with an Ethnic Studies faculty member and her students from a Gender, Race, Culture, Science, and Technology course. Students participated in a role playing activity that exposed students to different perspectives and norms of engineering cultures across the world. The collaborative activity led into a reflection using an Identity Wheel which prompted students to engage in discussion around their personal and social identities such as race, ethnicity, gender, socioeconomic status, age, and first language (adapted from "Voices of Discovery", Intergroup Relations Center, Arizona State University). For Week 7, we had students choose a social issue or current event that is affected by engineering. Students had to research the topic in groups and then give a brief presentation on their topic to the whole class. These presentations led to engaging discussions of how engineers are involved in the solution to societal and environmental problems. A Political Sciences faculty member from the liberal arts college came to speak during Week 9. She shared her experiences designing and implementing appropriate technologies for a developing island

community. Her interactive presentation addressed the importance of learning from and engaging with local people in order to identify the problem and implement a sustainable solution. The goal of including such activities and presentations in this course was to broaden students understanding of who engineers are and what they do.

Community service and outreach was another core emphasis in the class. In Week 8, we had a STEM outreach training, which addressed stereotypes of engineers and scientists, and provided tips to avoid these stereotypes in order to better encourage younger students from diverse backgrounds to consider STEM fields[24]. Students were required to participate in at least one STEM outreach event during the quarter. Most students participated in an event that brought middle school students to campus to participate in engineering labs and competitions. Others could choose to give a college recruitment presentation at their high school.

Written reflections were a significant component of the course design. Reflection is a metacognitive tool that we employed in our design to offer students opportunities to connect with their past experiences, prior knowledge, current feelings as well as think about how course topics and readings might impact their future. The course was designed to have a developmental approach rather than a "facts"-based approach. Throughout the course, students were assigned a total of seven reflections. For each reflection, we provided a prompt with a variety of questions relevant to the course content of that week. Students responded to the prompts individually and submitted them through our online course page. The reflections were not graded on a point scale; although students were given participation credit for submitting a reflection on time and given personal feedback. To encourage thoughtful reflections, we talked about the benefits of self-reflection in regards to their transition to college and understanding of engineering.

Participants

A total of seventeen students enrolled in the course. Seven of the students were required to take this course because of a scholarship they received, and the other ten self-selected into the course. The course was advertised as being especially designed for first-generation students.

All seventeen of the students were identified as first-generation, which the university defines as a student whose parents did not report completing a four-year degree. Fifteen out of the seventeen students were Pell-eligible, a status that is dependent on their expected family contribution (EFC). The two students who were not Pell-eligible were just outside the EFC range and were still eligible for state grants. In terms of ethnicity, our students identified themselves as the following: eleven (65%) as Hispanic/Latino, five (29%) as Asian, and one as Middle Eastern. Ten students identified themselves as male (59%), and seven (41%) identified as female.

Other similar courses and programs

ENGR 101 stands out among other efforts on our campus for first-generation and underrepresented minority students in a couple ways. First of all, this course is tailored to the experience of first-year *engineering* students, rather than the entire student population. Another program on our campus that serves a similar demographic as ENGR 101, Educational Opportunity Program (EOP), offers a freshman seminar series to support students' transition to college. The seminar series is less catered to any particular major and it emphasizes time management, study strategies, campus resources, and other college success skills. This contrasts

to ENGR 101's focus on engineering identity, relationship building, diversity, personal reflections, and social awareness. Second, the fact that ENGR 101 is a course (versus seminar, workshop or program) makes it different from other initiatives on campus. There are scholarship programs and other support services on campus that offer one-time workshops in the residence halls and seminar series that have similar goals to ENGR 101, but these efforts do not have the same environment or participation as a formal course does.

IV. Methods

We chose to use a mixed method framework to engage in both qualitative and quantitative datas. Data were collected throughout the quarter through faculty observation, student reflections, and surveys. Students completed an informed consent form on the first day of class and were aware that the study would protect their identity.

Data Collection

Mixed methods is a type of research that incorporates both qualitative and quantitative research techniques into a single study[13, 14]. This method was chosen because it can provide a rich narrative to the numbers from this study which is important considering the small scale of our research.

Qualitative

A qualitative study as defined by Denzin and Lincoln (2005) is "a situated activity that locates the observer in the world" (p. 3)[6]. The qualitative components of our framework allowed for in-depth analysis on the behavior and perceptions of the study participants through their written reflections, engagement with a mid-term chat, and our observations as instructors. By incorporating several points of qualitative data, we worked to thoroughly examine the experiences of the students from different perspectives; this method in qualitative research is called triangulation. Denzin and Lincoln described triangulation as "not a tool or a strategy of validation, but an alternative to validation" (p. 5)[6]. The process is not to provide an objective view but rather to show the depth and complexity of study through the multiple perspectives represented through the different data. Student reflections ranged from a paragraph to a page or so in length. It is important to note that there was 100% student participation in all seven reflections assignments throughout the quarter even though they were not graded. As instructors of the course, we met regularly to discuss the weekly reflections, activities in class, and the observations we made of students during class and throughout the campus. These were informal, but added to our own depth of understanding on how the students were engaging with the course and their engineering identities. We also utilized a service in our Center for Teaching, Learning and Technology called a mid-term chat. A mid-term chat is an opportunity for a curriculum specialist to come into the class and conduct an anonymous evaluation of the course structure and content. The curriculum specialist is also an expert on diversity and inclusivity. The mid-term chat provided students with a mechanism to reflect on what was working well with the course, what was not working well, and offer suggestions to improve the course mid-way through the quarter. Students were also asked to reflect on what they could do to improve their learning.

Quantitative
Quantitative data were collected from students' pre- and post-survey responses. Anonymous pre- and post-surveys were used because they tend to produce honest, unbiased responses from the participants. Through these surveys, we wanted to capture our students' perceptions of engineering and their sense of belonging within their majors at the start and end of the quarter. The questions were identical in the pre- and post-surveys, and there was a total of five 4-point Likert scale questions and four short answer questions in both surveys. As an example, students could choose from the following Liker scale responses: "Very Useful" (1), "Useful" (2), "Somewhat Useful" (3), or "Not Useful" (4).

The following two questions were used to assess students' understanding and confidence in their engineering identity:

- Q1: Based upon your description of your field, how confident are you that an engineering professional would agree with your description?
- Q5: How prepared are you to facilitate a STEM (science, technology, engineering, mathematics) outreach activity to younger students?

The following three questions captured students' sense of belonging in engineering and the university community:

- Q2: How useful do you feel the university resources have been for you this quarter?
- Q3: How connected and supported do you feel by your peers and community?
- Q4: How comfortable do you feel about seeking out your professors with questions and concerns?

Data Analysis

Qualitative
Reflections were read and analyzed using a discourse analysis technique. Discourse analysis is a qualitative research method that aims at uncovering meaning from written and spoken language (10). For each reflection we kept in mind the study questions and took note of how the student engaged with their engineering identity and sense of belonging. The depth and significance of the reflection was judged in part by the student's ability to tie in past experiences with how they understand the present and future. Themes were identified for each weekly set of reflections as they connected with the purpose of the prompt and the activities engaged in during that week. We also allowed room for additional themes to emerge from the data. The reflection analysis was conducted primarily by one individual. Throughout this process she utilized the curriculum specialist as a co-reader and reference for analysis specifics. Several times during the analysis we all met to check the analysis process by analyzing a sample of the reflections together. This provided consistency in the analysis as well as an opportunity for the lead analyst to bracket, a form of reflection and in this case research team support, to expand understanding surrounding the analysis process and meaning drawn from the data.

The data from the mid-term chat was analyzed by the curriculum specialist and provided to the instructors in the form of a report. The report used anonymous individual reflections of the students, small group consensus answers, and a whole group consensus to answer four questions about their experiences from the class. We used this information to help us gage how students

were working through the course construction up to the middle of the term, and what we might need to alter in the second half of the course to meet students' needs.

Our own observations and conversations about the students and the course helped us to engage in reflective practice. The reflections we ended up talking about focused on our own participation with creating the curriculum, teaching the course, and all of the other aspects that go into mentoring, talking with students, and excitement surrounding the course itself. These conversations were often informal and occurred right before class and after, in office hours, and also in social settings.

Quantitative

Our goal in analyzing the quantitative survey data was to capture the movement of individual students, as well as the group, from the beginning and end of the quarter and to find any trends from the class overall. Due to the small number of students in the study, there was a limited number of statistical tests that could be run on the data. Small population aside, we felt that the pre-/post Likert questions were essential to contributing to our research questions.

We wanted to see if there was a significant positive shift between individual students' responses in the pre- and post-surveys. To do this, we created a variable called "Change" which was equal to the pre-survey response minus the post-survey response. As an example, if a student responded with "Useful" (2) in the pre-survey and then with "Very Useful" (1) in the post-survey, their "change" variable would be +1. Descriptive statistics were used to summarize our findings from the survey data.

V. Findings

In this section, we share themes that were uncovered from the qualitative and quantitative data collected throughout the study. First, we describe findings from the student reflections, and then we provide results from our pre- and post-surveys. We are focusing specifically on these two data points with the understanding that our observations and the information from the mid-term chat are woven into the way we made sense of this data in particular.

Reflections

In effort to answer our research questions, we identified themes from the student reflections relating to following (1) Engineering Identity and (2) Sense of Belonging. Throughout the quarter, we noticed that many students reference their families, communities, and engagement in physical and social activities surrounding their work as important aspects of who they are as engineers. We considered these themes connected to students' engineering identities, and we identified them as "Family" and "Community."

(1) Engineering Identity

In effort to understand our students' engineering identities, we were looking for themes related to their knowledge of the engineering field and their expectations of the field, specifically what they want and need professionally. When describing their motivation for attending college and studying engineering, many students expressed a strong desire and responsibility to repay their parents and make them proud. We identified this theme as "Family." These students were aware

of the financial challenges and lack of educational opportunities that their parents had faced which motivated them to make the most of their college experience.

In terms of motivation for studying engineering in college, one student reflected:

> *My most important goal, and the main reason why I continued my education to the university level is my parents. My parents have busted their backs working since they were kids. They never had the opportunity to study. Both my parents told me they used to love going to school, but that money problems did not allow them to continue studying. I'm going through like if I were them. I'm making sure all their hard efforts have paid off. I will make my parents proud.*

This student's desire to get the most out of his time at school is connected with his desire to make his family proud and honor their sacrifices. Family responsibility is part of an identity rooted in the belief systems of many first-generation, URM students[8]. Another student reflected on her goals to repay her family through her career as an engineer, and included, *"I know materialistic things shouldn't make you happy, but for my family, I would love to be able to give them luxuries we're never had and to especially allow them to travel back to their country."* Ten students, both female and male, made reference to family responsibility at some point throughout the quarter, highlighting the importance of this theme. Family and balance was represented as a strong theme during the Values Affirmation class activity during which students had to prioritize their top five values from a list of over fifty values[18]. Students were able to see similarities and differences among their peers, giving them insight into the professional engineering identities that their classmates are forming in relation to their own.

Some students' described their desire to give back to their communities and make a social impact when explaining why they chose to study engineering. These students showed a strong foundation for their engineering identities; they understand connections between the engineering profession and local or global social issues. This theme was identified as "Community."

When asked about their career and life goals, one student reflected:

> *I definitely want to continue helping fight poverty at a local and international level. Through my major Civil Engineering, I will have the skillset it takes to help make an impact on the issue of affordable housing available to people….I feel like I was blessed to make it out of a rough community growing up in order to help change that stigma [X city] has.*

This student's engineering identity is tied to making an impact within the community. Throughout the quarter, ten students articulated a similar desire to give back to communities, locally and globally. Similar to those who want to support their families, these students want to help others through their engineering degrees. Many students also expressed interest in Engineers Without Borders (EWB), a student organization that implements service projects in countries around the world. In Week 7, many students identified with the presentation that was given by a faculty member who shared her research and humanitarian work around appropriate technologies for a developing community. The students were very engaged during this presentation, asked many questions, and showed interest in getting involved in similar projects during their time in college.

Through these reflections we got a glimpse into students' thought processes and learned what is important to them in regards to their academic and professional careers. The in-class activities throughout the quarter supported these students' desire to give back to their families and communities, thus strengthening their identity and connection to engineering.

(2) Sense of Belonging

Sense of belonging within engineering is negatively affected by stereotypes of who belongs in the field. This is why we analyzed students' perceptions of how their personal and social identities intersected with engineering. Each student in the class was a part of an underrepresented group within engineering (based on their gender, ethnicity, first-generation status, and/or low-socioeconomic status); therefore we identified themes around how students felt like they "did" or "did not" belong in engineering based on these identities.

We noticed a discrepancy between the female and male students in the way they talked about their identities belonging in engineering. Female students showed a lack of belonging and self-consciousness in engineering based on their gender; whereas, the male students articulated more confidence and motivation as a minority in engineering. When asked to consider how their personal identities intersect with engineering, five out of the seven female students in the class expressed feelings of being excluded from engineering because of their gender. In the Week 4 reflections, these five female students used words such as *"self conscious," "disadvantage,"* and *"insecure"* when reflecting on being a woman in engineering. One student wrote that *"many people don't take me seriously when I tell them I am an engineering major [b]ecause they think I look more like a liberal arts student."* Another student wrote that her identity as a Hispanic, low-income, and female caused *"conflict in my personal life because close family and family friends don't support my decision to become an engineer."*

These words and phrases indicated a lack of belonging in engineering classrooms and the field overall, along with some tenuous family support, which demonstrated a need for more interventions that address the underrepresentation of women in engineering. The activities and reflections focused on identity increased these female students' awareness of discrimination that women face in engineering and showed them that they are not alone in how they feel in their engineering classrooms. Later in the quarter, when asked to research and present on a social issue that relates to engineering, a group of female students chose to research the gender gap in engineering and shared a presentation to the class about the underrepresentation of women in their fields.

Some of the male students acknowledged being an ethnic minority in engineering, but for most of these students, they saw their minority status as motivating to prove themselves and their race/culture. Unlike their female peers, the male students did not express concerns about feeling like they don't belong based on any of their identities. When reflecting on being an ethnic minority within engineering, one student articulated that this has *"challenged [him] to do great things,"* and another mentioned how his identity has *"pushed [him] to do better in life."* Another student wrote that he is *"proving that minorities aren't going to be pushed around but that we are going up in this world."* Eight out of the ten male students demonstrated a similar confidence when reflecting on the intersection of personal identities and engineering. These students are aware that their ethnic identities are underrepresented in engineering, but they use this as motivation and reasoning for belonging in engineering.

In regards to their sense of belonging, nearly all of the students spoke positively about their experience in ENGR 101 at the end of the quarter. Students utilized words including *"welcomed," "friendly,"* and *"comfortable"* when describing their experience in the class. One female student shared that *"Engineering 101 has shown me the importance of diversity in engineering,"* and another female student wrote that *"this class broadened my view that engineers can be anyone."* Students also specifically wrote about the friendships and connections they made throughout the course. Even for students who struggled or experienced homesickness, they still felt that this course had a positive effect on their first quarter. One male student who wrote about many struggles he faced throughout the quarter also included that *"ENGR 101 has helped me learn about why I am here and why I should remain in the field."* It is clear from these reflections that ENGR 101 provided students with an environment and resources to promote a sense of belonging on our campus and in their engineering fields.

Pre- and Post-Survey

The pre- and post- surveys showed us that there was overall a positive movement in students' formation of engineering identities and sense of belonging throughout the quarter. Again, due to the small size of this study, we could not make broad generalizations for first-generation or underrepresented minority students in engineering; however, the surveys, with support from the qualitative reflection data, show that this course was an effective intervention for this student population at our university.

The most significant change from the pre- and post-surveys was seen for Q3 and Q5, which can be seen in Figure 1 and 2, respectively. We felt that Q3 demonstrated positive movement in our students' sense of belonging, and Q5 showed growth in their engineering identities.

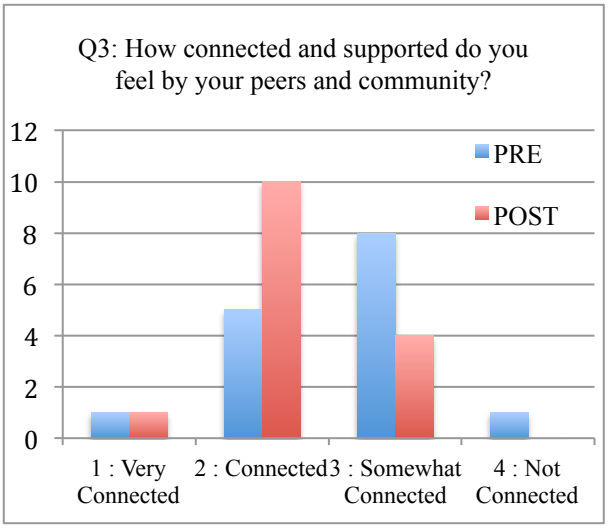

Figure 1: Pre- and post-survey response frequencies for Q3 (connectedness and support) that show shift towards more connectedness by the end of the quarter.

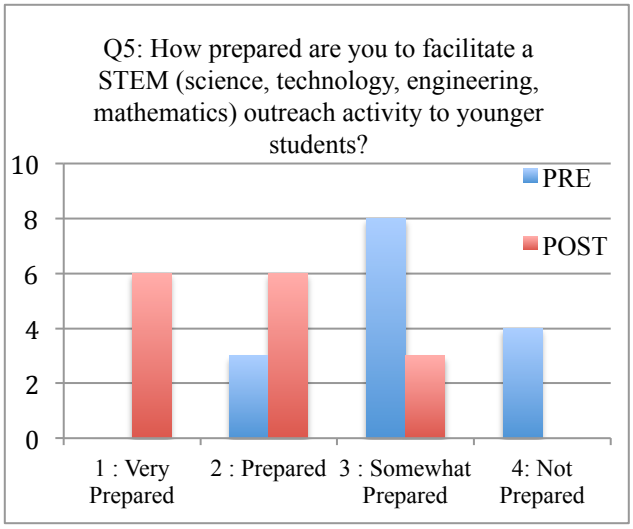

Figure 2: Pre- and post-survey response frequencies for Q5 that demonstrate a dramatic increase in feeling prepared in their ability to facilitate STEM outreach activities to younger students.

In Figure 1, we see that eleven students reported feeling "Connected" or "Very Connected" to their peers and community at the end of the quarter compared to only six students at the start of the quarter. An increase in the connection students have with their peers and community demonstrates an increase in the students' sense of belonging. In Figure 2, we see a significant positive shift in how prepared students feel in working with younger students for STEM Outreach. Twelve students felt "Prepared" or "Very Prepared" at the end of the quarter compared to only three students at the start of the quarter. As students feel more prepared to work with younger students through STEM activities, they become advocates for engineering and the sciences, demonstrating development and strength in their engineering identity.

To adjust for students' response in the pre-survey and to capture individual change between pre- and post-surveys, we calculated a "change" value, which is summarized in the table below. We categorized the "change" variable as follows: "Negative Change" included -3, -2, and -1; "No Change" included 0; and "Positive Change" included 1, 2, and 3.

Table 2. Count of students who have had "Negative Change," "No Change," and "Positive Change" in student responses from the pre-survey to the post-survey

Question	**Count of Students with "Negative Change"**	**Count of Students with "No Change"**	**Count of Students with "Positive Change"**
Q1: Based upon your description of your field, how confident are you that an engineering professional would agree with your description?	**1**	**10**	**4**
Q2: How useful do you feel the university resources have been for you this quarter?	**3**	**9**	**3**
Q3: How connected and supported do you feel by your peers and community?	**1**	**8**	**6**
Q4: How comfortable do you feel about seeking out your professors with questions and concerns?	**3**	**6**	**6**
Q5: How prepared are you to facilitate a STEM (science, technology, engineering, mathematics) outreach activity to younger students?	**0**	**2**	**13**

As seen in Table 2, the most significant movement between the pre- and post-survey occurred for Q5. The mean change for Q5 was 1.27 with a standard deviation of 0.88. Though not necessarily statistically significant, there were some other changes between the pre- and post-surveys that stood out to us as instructors. In Table 2, we see that for Q1, a vast majority of the class (fourteen students) showed no change or positive change when asked about their confidence in describing their field of engineering to a professional. In the pre-survey, eleven students reported feeling "Very Confident" or "Confident," so there was little room for them to show improvement. This shows us that many students had a fairly solid and basic understanding of their engineering discipline at the start of college, possibly due to the requirement of selecting a major as part of the application process to the university.

Table 2 also shows that three students felt less comfortable about seeking out professors than they did at the start of the quarter based on their responses for Q3. A negative experience in the classroom or a lack of connection with professors may have led these students feeling less comfortable throughout the quarter, which prompted us to think of more questions to ask the students (i.e. Have you used office hours? Do you feel that your professors care about your success? Are there any reasons why you do not want to go to office hours?). These questions will be considered for future iterations of this course, and we may include interventions that would support students in building relationships with professors.

VI. Conclusion

In this study, we sought to describe the effects that ENGR 101 had on the development of an engineering identity and sense of belonging for first-generation, URM students during their first quarter of college. Through our mixed methods study, we showed the impacts of student participation in the course as well as themes identified from the reflections and survey responses. Our study was driven by two research questions: (1) What can we learn from an emphasis on intentional activities and reflective writing to help first-generation students develop an "engineering identity" and ownership over their engineering major? and (2) Does a course focused on relationship building, diversity, and social awareness improve first-generation students' sense of belonging within the College of Engineering?

From the reflective writing and in-class activities, we learned that students' engineering identities are closely tied to family responsibility and community engagement. By articulating their knowledge, motivation, and desires, these students demonstrated an ownership over their engineering identities. The course activities focused on personal values, diversity, social issues, and community engagement affirmed students' connection and identity with engineering. These reflection assignments were incorporated into this class not only as a means of gathering data from the students, but also, and more importantly, the reflections gave students an opportunity to be heard. Based on the full participation and quality of the reflections assignments, we believe that the students' engineering identities were strengthened from these assignments.

The reflections and our own observations also showed us that this course had a positive impact on the students' sense of belonging and community among their classmates. Overall, this course helped broaden many students' perceptions of who engineers are and what they do, showing them that they do belong in their fields. By thinking about their personal identities in engineering and being exposed to the importance of diversity in engineering, many students realized that they not only belong in engineering but that they are needed. Throughout the quarter, we had close to 100% attendance with very few students missing a class or two. Students genuinely seemed to enjoy coming to class and interacting with their peers, especially considering that this course was offered in the evening, was credit/no credit and not necessarily counting towards their degree. We noticed friendships forming as students talked together before class started and waited for each other as class ended. Many of the students regularly asked questions after class and seemed comfortable engaging with their classmates and instructors. These observations further support our findings from the reflections and surveys. ENGR 101 played a significant role in creating strong and authentic support network for these students, thus increasing their sense of belonging during their first quarter of college.

The quantitative pre- and post-survey data showed us that there was positive movement in students' engineering identities and sense of belonging while participating in this course. Thirteen students reported feeling more prepared to facilitate STEM activities for younger students by the end of the quarter, showing development and strength in their identity and connection to engineering. In regards to their sense of belonging, eleven out of the seventeen students reported feeling connected with their peers and community by the end of the quarter, compared to only 6 at the start of the quarter. This increase in students' sense of belonging is supported by the final reflections in which nearly all the students spoke positively of the class environment that supported community and friendship development.

This study provides endorsement for continuing to offer ENGR 101 at our university and for incorporating similar activities into other introductory engineering courses. Below, we provide recommendations for those interested in implementing similar interventions at their university and our vision for future iterations of the course and how we plan to expand our efforts.

Recommendations

We recommend that other institutions consider a similar course to support first generation and URM students. ENGR 101 differs from other introductory engineering courses because of its emphasis on reflective writing, relationship building, diversity, and social awareness. These aspects of the course are essential for facilitating a classroom environment that embraces the individuality and strengths of students. Implementing a course similar to ENGR 101 can have a positive effect on first-generation, URM students' development of their engineering identities and their sense of belonging in the field.

Alternatively, some of the interventions used in ENGR 101 can also be interwoven into traditional introductory engineering courses. Incorporating group discussions, personal reflection assignments, diversity and value-affirmation activities are relatively simple interventions that can help foster an encouraging environment for first-generation and underrepresented minority students, as well as majority students. Many of the activities have already been developed by others and are available on campus libraries or online (i.e. value-affirmation, identity wheel). We also recommend collaborating with university partners (i.e. career centers, advising, engineering and non-engineering faculty, etc.) for presentations and workshops.

Future Iterations and Growth

The insights gleaned from the study, as well as student feedback, will inform future offerings of this course. Based on the positive experiences of the students and instructors, much of the course structure overall will remain the same, but adjustments will be made to better serve the students. We also hope to attract a larger number of students by implementing a more strategic marketing plan and offering the course at a more ideal time. This class can easily accommodate closer to 30 students.

For future studies on ENGR 101 at our university, we would like to collect data from a control group of first-generation, URM students to compare students' sense of belonging and engineering identity between those who did and did not participate in the class. To investigate the long-term effects of this course, we will follow up with students via surveys and focus groups to gauge their satisfaction and success as they progress through their engineering degree.

In regards to expanding the efforts of ENGR 101, we plan to offer ENGR 301 *Engineering Professional Success*, which will focus on professional development and career readiness. We observed that students were very engaged and interested during class sessions that focused on industry and other opportunities after graduation, so ENGR 301 will be designed to further support the professional success of first-generation and underrepresented minority students. This course will be offered under the same grant and will target upperclassmen and transfer students. Like ENGR 101, this course will also incorporate group discussions, reflections and diversity activities in addition to professional skills such as networking and resume writing.

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