First in My Family: A Comparison of Subject-Related Role Identities by Parental Level of Education and Gender

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***Abstract*—In this full, research category paper, we examined the differences in subject-related role identities of first-generation and continuing-generation college students by gender. Subject-related identities have been linked to important educational outcomes and consist of identifying as a math person, physics person, and an engineer. These identities are formed through interrelated factors such as interest in the subject, beliefs about being able to understand the subject material (i.e., performance/competence beliefs), and internal/external recognition. The data came from a large-scale survey administered in introductory to engineering courses at 32 four-year ABET accredited institutions. Women in particular were significantly more likely to be interested in mathematics compared to men. Additionally, our study indicates that women first-generation and continuing-generation college students were less likely to be recognized externally and internally as a physics person, while men continuing-generation college students were more likely to have external and internal recognition in physics. Both men first-generation and continuing-generation college student groups were more likely to feel confident in their abilities to understand and do well in physics. Men in both groups were more likely to feel confident in their abilities to understand and do well in engineering compared to women in either group. Both women and men who are first-generation college students were less likely to feel like engineers in their first-semester of their engineering program. These results illustrate the areas of strength with which first-generation and continuing-generation college students enter engineering programs, as well as the areas of continued support for their developing identities.**

Keywords—first-generation college students, engineering identity, physics identity, mathematics identity

I. Introduction

Achievement in mathematics and science courses support high school student's decision to pursue a STEM (science, technology, engineering, mathematics) degree [1]–[3]. Additionally, we know from prior work that seeing oneself as a physics and math person supports the choice of an engineering major [4]–[8]. More recent work has expanded our understanding of how students choose engineering by empirically establishing that a mathematics and physics identity directly supports the development of an engineering identity [9]. Students' development of a subject-related role identity results from exposure to course material inside and outside of the classroom [10], [11]. Yet, the messages students receive in high school about the types of people that can do mathematics, science, physics, and engineering can also influence the trajectories they take in college. In a study examining high school students perceived access to mathematics, physics, and engineering identities, a common theme from students was, "you have to be a science person and a physics person and a math person to be an engineer because it kind of includes all three" [12]. In this same study, Verdín et al. [12] found that high school students discussed anyone as being capable of assuming a math or science identity if they worked hard or were interested enough. In contrast, these same students tended to limit who can be a physics person or an engineer. Specifically, high school students described those who can be a physics person and an engineer as an identity held by the elite (i.e., saw the world "differently" than most people) or "super smart" people [12]. This result is consistent with other work that frames engineering as a meritocratic pursuit with limitations of who can become an engineer [13].

However, not all students take physics courses, and in some cases, students may be deterred from taking physics altogether. For example, in a study of high school students' understanding of STEM roles, Casey stated, "I feel like it [physics] should be pushed more. Like they pushed, ah, Earth and Space really hard …" [12]. There was a low number of women enrolling in physics in her school, and the course topics were not encouraged by teachers or advisors. Later on, in her second semester of her first-year engineering program, Casey became involved in Project Lead the Way through her mom's encouragement and despite her school's implicit opposition. She shared, "my mom was like, yeah they didn't want to put any of the girls in engineering because they were like, oh this just for the boys, so they presented the girls with Spanish and the boys with engineering."

While there are certainly efforts to support women's participation in engineering, there are still subtle and not so subtle ways of systematically excluding women from experiences that provide access for underrepresented students to author a physics and engineering identity. As well, parental involvement, as we saw in the narrative account of Casey, plays an important role in supporting participation in STEM-related courses and activities. Parental involvement is essential in students' early years and high school [14]. In students' adolescent years, Harackiewicz and colleagues [15] found that parents continue to play an important factor in their students' pursuits. Students with parents who were provided support on how to talk to their adolescent about the importance of mathematics and science course-taking in high school (i.e., experimental group) subsequently took more STEM courses than those in the control group [15]. A study following students from middle school to the transition into college found that parental level of education was predictive of taking mathematics and science courses in both high school and college [16]. This same study found that both parents' perception of the utility of STEM courses was greater for those parents with higher levels of education [16]. For students who are first in their families to attend college, the messages that students receive at school and at home may play an even more important role for students' STEM identification.

A. Understanding First-Generation College Students' Pursuit of an Engineering Degree

Scholars have examined the experiences supporting first-generation college student's intention to pursue engineering, emphasizing the importance of pre-college engineering experiences. For example, Strutz and Ohland's [17] study of eleven first-generation college students found informal learning environments, interest, perception of who engineers are in society, advanced skillsets in STEM subjects, and STEM-knowledgeable individuals' encouragement and support were important in fostering first-generation college students' intention to pursue engineering. The STEM-knowledgeable individuals cited by half the participants were Advanced Placement (AP) or Honors physics, chemistry, mathematics, and programming teachers [17]. Stutz and Ohland [17] emphasized how Julie, a chemical engineering student, was recognized, by her AP and honors chemistry teachers, as proficient and having a genuine interest in chemistry, "someone recognizing that I have a proficiency and … interest helped me … Otherwise, I wouldn't have noticed…" [p. 8]. Similarly, in a study by Strutz [18], first-generation college students noted the importance of STEM-talented friends, mostly in science and/or mathematics courses, as sources of influence towards their decision to pursue engineering.

Martin et al.'s [19] recent work found differences between family support structures among first-generation and continuing generation college students' in engineering. Their work concluded that continuing generation college students noted that their parents helped reinforce their aptitude in math and science and encouraged their interest through expressive targeted activities, programs, and toys [19]. However, while the first-generation college students did receive encouragement from their family, the encouragement was broader, i.e., "work hard and get a good career …" or engineering is a means to a financially secure life [19, p. 18]. This form of encouragement motivates a stable and financially secure future; however, it may not provide the recognition needed in key subject-related areas such as mathematics, physics, or engineering.

Despite these findings, there is still an incomplete understanding how students who are the first in their families to pursue college degrees become interested, recognized, and gain competence beliefs in STEM domains. Interest, recognition, and competency beliefs are mechanisms that support students' authorship of subject-related role identities. This study examines these identity shaping mechanisms and how they may be more or less developed for students who differ when considering parents' level of education.

II. Theoretical Framing

A *role* is described as a "set of expectations tied to a social position that guide people's attitudes and behaviors" [20, p. 114]. The social position of being a "student" is intimately tied to the role (i.e., expectations) of learning, acquiring new skill sets, studying, passing courses, progressing towards degree completion. The expectations of a role are learned through a range of interactions with others. Understanding the definition of a *role* is important to the definition of *role identity*. A role identity consists of "internalized meanings of a role that individuals apply to themselves" and expectations associated with the roles [20, p. 114]. The internalized meanings and expectations guide behavior and help define who is in that specific role [21]. For example, a student who takes on a role identity of an engineer adopts the meanings and expectations that accompany the specific role "and then act[s] to represent and preserve these meanings and expectations [22]. Our study is situated in the post-secondary context; therefore, students occupy a role identity, not through a professionalization lens (i.e., physicist) but through a subject context lens (i.e., physics person, math person, or engineering). This form of identification is understood through Gee's interpretation of identity as "being recognized as a certain 'kind of person' in a given context" [23, p. 99]. Thus, the authoring of a role identity within these contexts is done through three dimensions: interest, recognition, and performance/competence beliefs.

Students learn the meaning of being a physics "kind of person" or engineering "kind of person" when they display an ability to perform their competence and understanding of subject content material. In framing a science identity, Carlone and Johnson [24] defined performance as "relevant scientific practices (e.g., ways of talking and using tools)" and competence as "knowledge and understanding of science content" [p. 1191]. Recognition is, therefore, both an external manifestation and internal state, both of which are required for identity development [24], [25]. Gee [26] noted the contextual identity a student seeks to take on is further reinforced when "they are recognized by [themselves] or others" [p. 102].

The construct of interest was incorporated into the identity framework by Hazari et al. [27] to foreground the importance of developing interest for non-professionals in STEM career pathways instead of treating it as an implicit component of engagement. Interest has both an affective component (i.e., emotions accompanying engagement) and a cognitive component (i.e., activities related to engagement) [28], [29]. Interest is an internal state, yet students' interaction with content and their environment can promote or hinder interest development [28]. Interest is content specific and is not a general predisposition [30]. This framing of interest is important towards capturing students' interest in subjects such as mathematics, physics, and engineering.

To synthesize, students take on subject-related role identities when they hold interest in the subject, receive and internalize the recognition as a kind of person in a particular context, and demonstrate efficacy beliefs in understanding and displaying competency in the subject-related area. Recent work has shown that these three constructs are equally important for developing an identity as a math person, physics person, and engineer [9], [31].

III. Research Questions

In this study, we separately examine the different mechanisms that support subject-related role identities for first-year engineering students while using intersecting social identity markers (i.e., gender and parents' level of education) by answering the following research questions:

1) Are there differences in students' mathematics role identity measures at the intersection of gender and parents' level of education?

2) Are there differences in students' physics role identity measures at the intersection of gender and parents' level of education?

3) Are there differences in students' engineering role identity measures of students at the intersection of gender and parents' level of education?

By understanding the differences in the identity shaping mechanisms among students who differ by gender and parents' level of education, we can create targeted support efforts to help sustain interest, promote recognition, or reinforce students' performance/competence beliefs.

IV. Method

A. Dataset

Data for this study came from a large-scale survey administered in the fall of 2017 in introductory engineering courses at 32 four-year Accreditation Board for Engineering and Technology (ABET) accredited institutions. The overall sample of **first-year engineering students** was 2,642. A total of 605 (23%) of students specified their parents' level of education as either "less than a high school" diploma," "high school diploma/GED," or "some college or associate/trade degree" (i.e., first-generation college students) and 1,779 (67%) identified having one or more parents with a bachelor's degree or higher (i.e., continuing-generation college students). The remaining 258 (10%) did not indicate their parents' level of education. We cannot determine why these students did not report their parents' level of education, but some possible reasons may include survey fatigue, inadequate time allocated to administering the survey in class, or the student did not know parents' level of education. Since this study sought to understand the differences between college student generation status, students who did not report their parents' level of education were removed from the analyses.

B. Analysis

Before the analysis, data were cleaned of indiscriminate responses. A multiple imputation method using expectation-maximization from the Amelia II package in R was used to account for missing data [32]. A multiple imputation method is more robust than listwise deletion as it reduces bias in model parameters. Following, data were checked for univariate and multivariate normality and multicollinearity. Univariate normality was found to be within acceptable skewness range (absolute value of less than 2.0) and kurtosis range (absolute value of less than 7.0) [33], [34]. A Kruskal-Wallis test [35] for non-parametric data was used to determine if a difference exists between the four groups. Kruskal-Wallis test assumes that groups are independent of the outcome and from each other. However, this type of test does not provide further information on which groups differ. Therefore, when a difference was detected among the groups through the Kruskal-Wallis (KW) test, it was followed up by a *post hoc* test for multiple comparisons with a Benjamini-Hochberg adjusted *p*-value to avoid the possibility of making a Type-1 error. Benjamini-Hochberg correction controls for the false discovery rate (FDR) for multiple comparisons [36]. FDR accounts for the proportion of incorrectly identified mean differences (i.e., rejected null hypothesis when it should have been accepted). This method is shown to be "more powerful than comparable procedures which control the traditional familywise error rate" [37, p. 1165]. Following a significant KW test and after examining the post hoc results that appeared to show a trend, we used the Jonckheere-Terpstra test. A Jonckheere-Terpstra test is similar to a Kruskal-Wallis test. It tests for differences between median values among groups while also testing whether there is a significant, meaningful order to the group differences. Specifically, this test examines the specified order of the groups and determines if there is a significant ascend or descend order to their median values.

The analyses were conducted using the R statistical programming software version 3.6.1. The Kruskal-Wallis test was conducted using the *stats* package [38]. The post-hoc test was conducted using the *pgirmess* package [39].

C. Survey Measures

Engineering, physics, and mathematics identities consist of three latent measures, i.e., interest, recognition, and performance/competence beliefs. Prior work has shown strong validity evidence for the constructs of engineering identity [40], [41], physics identity [4], [27], and mathematics identity [42]. For all STEM role identity measures, students were asked, *To what extent do you agree or disagree with the following statements* and were provided with a 7-point numeric scale, ranging from 0-strongly disagree to 6-strongly agree. Three sets of items were used to capture students' engineering interest, physics interest, and mathematics interest. Three sets of items were used to capture students' engineering recognition, physics recognition, and mathematics recognition. Lastly, four items were used to capture students' engineering performance/competence beliefs, six items for physics performance/competence beliefs, and five items for mathematics performance/competence beliefs. A single item was used to capture students' engineering identity belief: I see myself as an engineer, physics identity belief: I see myself as a physics person, and mathematics identity belief: I see myself as a math person. Additionally, we were interested in a targeted time perspective of students' identification as an engineer; therefore, students were asked to rate their level of agreement with the statement: I feel like an engineer now.

Construct reliability was evaluated using Cronbach alpha. The alpha values were as follows: mathematics interest α = 0.87, mathematics recognition α = 0.78, mathematics performance/ competence beliefs α = 0.92, physics interest α = 0.89, physics recognition α = 0.85, physics performance/competence beliefs α = 0.93, engineering interest α = 0.91, engineering recognition α = 0.80, and engineering performance/competence beliefs α = 0.90. All values are above the 0.70 recommended value [43]. After verifying that all items are closely related to their respective latent construct, a composite score was created to run the analyses.

D. Participant Grouping

Since our study sought to understand the differences between students at the intersection of two gender identities (i.e., men and women) and parental level of education, data were divided into four groups. Only responses that were men or women were used due to sampling limitations.

Our dataset of first-year engineering students had 137 women and 446 men who were identified as first-generation college students (FGCS), and 426 women and 1,276 males were identified as continuing-generation college students (CGCS). Although our analysis could not focus on specific race/ethnicities due to sampling limitations, we provide a summary in Table I for each group.

TABLE I. DEMOGRAPHIC INFORMATION

	WFGCS	MFGCS	WCGCS	MCGCS
Asian	20	58	63	163
Black or African American	13	29	26	63
Latino/a or Hispanic	22	90	30	98
Middle Eastern or Native African	2	9	7	18
Native American or Alaska Native	3	5	10	14
Native Hawaiian or another Pacific Islander	0	3	5	12
White	87	277	325	997
Another race/ethnicity not listed above	3	8	3	26

Note. WFGCS = women first-generation college students; MFGCS = men first-generation college students; WCGCS = women continuing-generation college students; MCGCS = men continuing-generation college students. Students were allowed to *mark all that apply* for their

V. RESULTS

We found differences between students' subject-related role identity measures and demographic grouping variables. A summary of the results from the Kruskal-Wallis test can be found in Table II. We followed up significant differences from the Kruskal-Wallis test with a post hoc test. The post hoc test conducts multiple pairwise comparisons across a baseline group; in our study, the baseline group is students who are the majority group in engineering, i.e., men continuing-generation college students. *Comparing groups across one baseline group* instead of conducting all possible comparisons helps reduce inflation due to Type I error rate. Boxplots were included at the end of each section to provide a visual representation of response patterns for each demographic group.

We acknowledge the tension some scholars may have with the practice of comparing minoritized groups of students against students who make up the majority in engineering. However, the historical norms of engineering create experiences for women, Black, Indigenous, and Latino/a/x students that are exclusionary and understanding the collective experiences of students who are systematically affected by these systems can provide ways to address key issues in students' pathways. We discuss results from the first mathematics identity measures, following physics identity, and lastly, engineering identity. The organization of the results are based on subject matter exposure and their influence on students' role identity formation. Students have the highest school exposure in mathematics, following physics, and lastly, engineering since there are few formal courses for this subject.

TABLE II. RESULTS OF KRUSKAL-WALLIS TEST

	KW- $\mathcal{X}^2$	Sig
I see myself as a math person.	-	-
Mathematics Interest	34.66	***
Mathematics Recognition	13.41	***
Mathematics Performance/Competence	9.60	*
I see myself a physics person.	58.09	***
Physics Interest	15.05	**
Physics Recognition	26.17	***
Physics Performance/Competence	17.96	***
I feel like an engineer now.	16.92	***
I see myself as an engineer.	-	-
Engineering Interest	-	-
Engineering Recognition	-	-
Engineering Performance/Competence	22.89	***

Note. * $p < .05$; ** $p < .01$; *** $p < .001$

A. *Differences Between Groups for the Mathemaics Role Identity Constructs*

The analysis found no statistically significant difference between students' beliefs of *seeing myself as a math person* by gender and parental level of education. There was a significant difference in students' mathematics interest ($H(3) = 34.66, p < .001$). A focused comparison between groups (i.e., gender and parental level of education status) found no difference in mathematics interest between men who differed by parents' level of education. However, a difference in mathematics interest was found when comparing men continuing-generation college students (MCGCS) to both women first-generation college students and women continuing-generation college students. Figure 1 demonstrates that women in both groups have higher median values and more values in the upper quartile than the baseline group (i.e., MCGCS).

We found a significant difference between group membership and students' mathematics recognition ($H(3) = 13.41, p < .001$). A closer comparison across groups uncovered one difference in mathematics recognition between women and men continuing-generation college students. No other difference for this construct was found. Figure 2 provides a visual representation of the median distributions between men and women continuing-generation college students.

A multiple comparison of students' mathematics performance/competence beliefs found that differences exists based on students' gender ($H(3) = 9.60, p < .05$). A focused comparison of median ranks found that women continuing-generation college students were statistically different compared to men continuing-generation college students. No other between-group differences were found for mathematics performance/competence beliefs. While women first-generation college students (WFGCS) had higher median scores than the baseline group (i.e., MCGCS), they also had a larger lower quartile than the upper quartile, explaining the lack of significant difference.

B. *Differences Between Groups for the Physics Role Identity Constructs*

When examining group differences from the variable *I see myself as a physics person*, the Kruskal-Wallis test identified a group difference ($H(3) = 58.09, p < .001$). A focused comparison of median ranks was implemented to help interpret the results from the Kruskal-Wallis test. We found differences between men first-generation college students, women continuing-generation college students, and women first-generation college students compared to the baseline group, i.e., MCGCS. A Jonckheere's test revealed a significant trend in the data $JT = 593814, p < .001$. The trend can be interpreted as the more the student group is marginalized in engineering, the more the median rank count for *I see myself as a physics person* shows a decrease. While women continuing-generation college students belong to both a minoritized and a majority group in engineering, they have lower median rank scores on the variable *I see myself as a physics person* compared to men first-generation college students. Similarly, women, first-generation college students, had the lowest median rank score than men

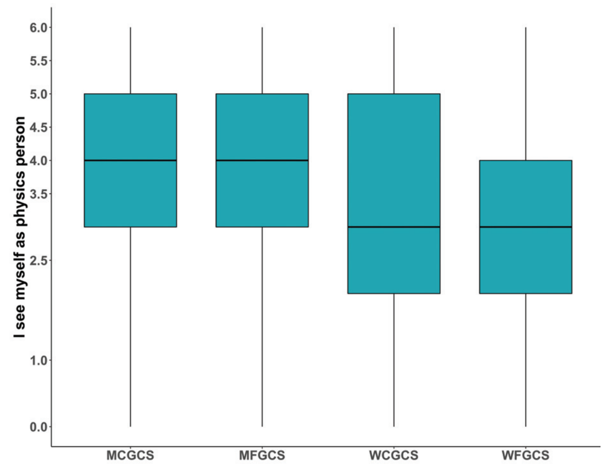

Fig. 4. Group comparisons for the single item, *I see myself as a physics person*

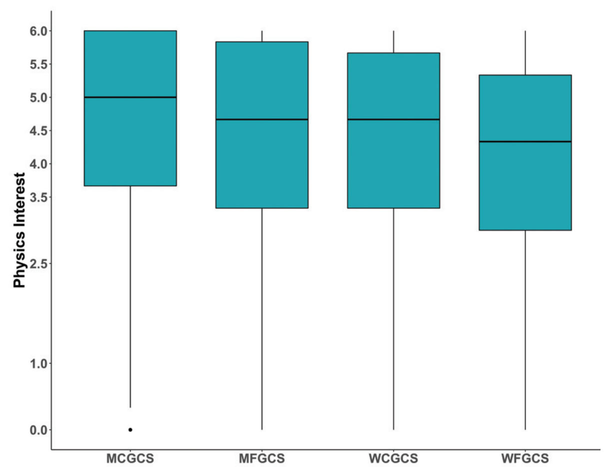

Fig. 5. Group comparisons for the physics interest variable

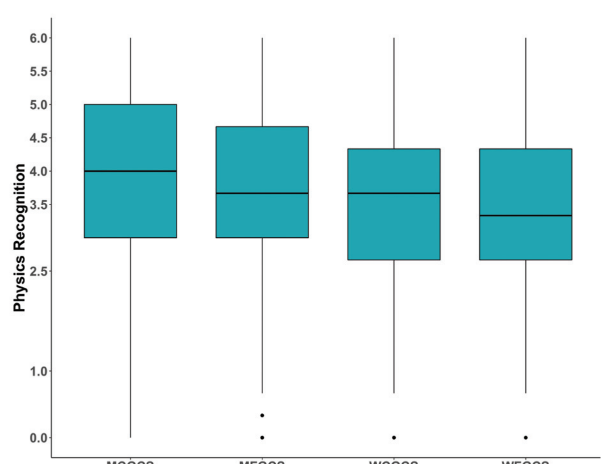

Fig. 6. Group comparisons for the physics recognition variable

first-generation college students and women continuing-generation college students. Figure 4 provides a visual representation of the median values, quartiles, and dispersion for each group.

When examining physics interest, a significant difference was found between groups ($H(3) = 15.05$, $p < .01$). A closer examination of group differences found that women both first-generation and continuing-generation college students had lower median ranked differences than men continuing-generation college students. No difference was found between male groups. Significant differences can be better understood in Figure 5.

Differences across groups were found for the physics role identity variable of recognition ($H(3) = 26.17$, $p < .001$). Specifically, we found that men first-generation college students rated themselves less favorably with respect to receiving external recognition in physics compared to men continuing-generation college students. Similarly, women from both groups (first-generation and continuing-generation college students) reported lower ratings on the variables pertaining to external recognition in physics compared to men continuing-generation college students. When examining if there was a significant trend in the data relative to students' marginalized position in engineering, the Jonckheere's test produced a significant effect $JT= 558270$, $p < .001$. Thus, the further marginalized the students are in engineering, the lower they are reporting receiving external recognition as a physics person. For example, men first-generation college students report receiving lower external recognition compared to men continuing-generation college students. Women continuing-generation college students report receiving lower external recognition compared to men in both groups. Lastly, women first-generation college students report receiving the lowest external recognition. The downward trend can be observed in Figure 6. While the two female groups have similar median values, there are more scores in the bottom quartile for women first-generation college students than their female counterparts. The last physics-related variable that was examined was physics performance/competence beliefs. A significant difference was found between groups for the self-reported measure of physics performance/competence beliefs ($H(3) = 17.96$, $p < .001$). A focused examination of the differences indicated that women continuing-generation and first-generation college students had lower reported measures for performance/competence beliefs in physics than men continuing-generation college students. This difference can be observed in Figure 7. No difference was found between men who differed on parental level of education.

C. *Differences Between Groups for the Engineering Role Identity Constructs*

No significant difference between groups on the indicator *I see myself as an engineer* was found. However, when examining the indicator, *I feel like an engineer now,* a significant difference was found by gender and parental level of education ($H(3) = 16.92$, $p < .001$). Women continuing-generation and first-generation college students rated themselves lower on the indicator, *I see myself as an engineer now*, compared to men continuing-generation college students

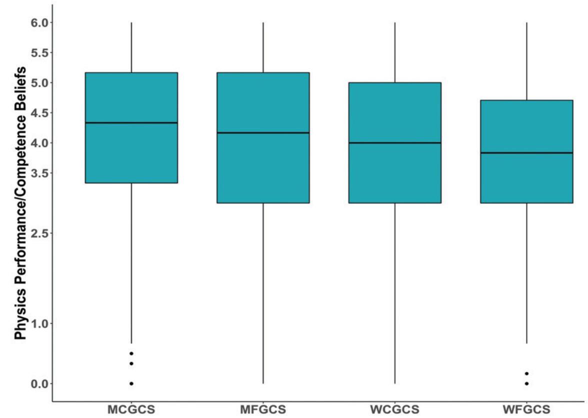

Fig. 7. Group comparisons for the physics performance/competence beliefs variable

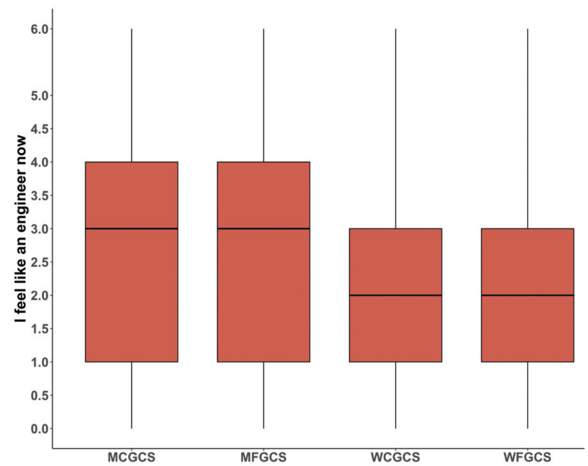

Fig. 8. Group comparisons for the single item, *I feel like an engineer now*

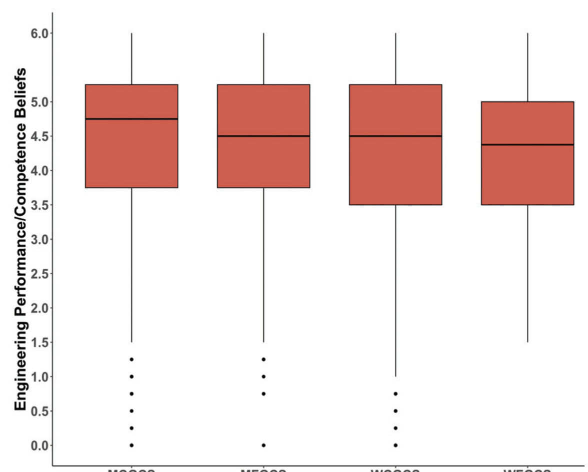

Fig. 9. Group comparisons for the engineering performance/ competence beliefs variable

(i.e., baseline group). No difference was found between men for the same indicator. The Jonckheere's test produced a significant effect $JT = 714062$, $p < .001$, indicating a significant trend in the data relative to students' group membership. Figure 8 provides a visual of the medians, quartiles, and dispersion across groups. Additionally, we found no significant difference for the composite scores of engineering interest or engineering recognition by gender and parental level of education. The last Kruskal-Wallis conducted examined differences across groups for the variable engineering performance/competence beliefs. A significant difference in engineering performance/competence beliefs by gender and parental level of education was found ($H(3) = 22.89$, $p < .001$). Women continuing-generation and first-generation college students rated themselves lower on their engineering performance/competence beliefs compared to men continuing-generation college students. No difference was found between men. Figure 9 demonstrates group distributions. The Jonckheere's test found a significant trend in the data relative to students' marginalized position in engineering, $JT = 672504$, $p < .001$.

VI. Discussion

Our findings provide a snapshot of the different identity-forming mechanisms (i.e., interest, recognition, performance/ competence beliefs) salient to first-year engineering students based on gender and parents' level of education. We compared three groups of students, women and men first-generation college students and women continuing-generation college students to a baseline group (i.e., men continuing-generation college students). There were two deterministic reasons for comparing students against one baseline group: 1) statistical reliability decreases and Type I error rate is inflated when all groups are compared to each other and 2) men continuing-generation college students make up a substantial portion of the engineering student population and thus influence the culture of engineering. Therefore, understanding the differences in the identity-forming mechanisms for each subject can shed light on support efforts for students interested in pursuing engineering.

We found that women from both groups demonstrated significantly greater interest in mathematics compared to the baseline group. The median values in Figure 1 show that women have higher median scores on the mathematics interest scale compared to both male groups. However, only women continuing-generation college students were more likely to be recognized as someone that can do mathematics and had higher performance/competence beliefs in mathematics compared to the baseline group. Mathematics interest and recognition, in a study by Cribbs et al. [5] who used a nationally representative sample of general college students enrolled in introductory calculus courses, were found to support students' choice to pursue engineering. Our analysis used similar variables for mathematics interest and recognition.

Prior work [5] underscores the importance of interest and recognition in mathematics for students' choice to pursue engineering. Our present study helps us understand that not all women may be receiving the external recognition as a math person despite showing greater interest in the subject. Demonstrating interest in mathematics should prompt influential others (i.e., instructors, peers, parents) to recognized their students' potential as a math person. Yet, this trend does not appear for women first-generation college students. We, therefore, call on educators to reflect on the types of students that are being recognized as interested math people. Rather than recognizing a student as a math person for their ability to perform, it may be more beneficial to recognize their interest in the subject and nurture a growth mindset towards their performance/competence beliefs. Shifting when students are recognized as a math person (i.e., due to their interest or due to their performance abilities) is incredibly important for first-generation college students as these students tend to be disproportionately enrolled in lower-level mathematics courses in college [e.g., 44].

The most disparities between student groups exist in the identity-forming mechanisms for physics role identity. Similar trends were found between the internal and external physics recognition variables. Students who are more marginalized in engineering had lower median values in seeing themselves as a physics person and being recognized by others as physics people. Specifically, men first-generation college students had significantly lower physics internal and external recognition ratings compared to men continuing-generation college students (i.e., baseline group). Additionally, women in both groups were less likely than the baseline group to see themselves as a physics person and be recognized by others as a physics person. Women from both groups had lower self-reported interest and performance/competence beliefs in physics compared to men continuing-generation college students. We know from prior work that developing a physics identity supports students' choice to pursue an engineering degree [4]. While the number of female high school students enrolling in physics is almost comparable to men, most tend to participate in the algebra-based physics course [45]. As well, prior work documenting the experience of one Latina's entry into engineering points to a hesitation and reservation towards taking calculus-based physics courses, i.e., "I knew I had to take a physics class … I was just still doubting myself … I honestly just thought I was going to fail at it, because only smart people did physics" [46, p. 158]. Other studies have also documented how high school students tend to perceive physics as only for smart people [10], [12], and unfortunately, students tend to perceive males as "smart" in physics [10]. Several studies have documented how women hold lower perceptions of their ability to do well in physics than men [47]–[49]. Most alarmingly, Marshman et al. [49] found that college women with high scores on a physics conceptual inventory (analogous to receiving an A) had similar self-efficacy scores compared to males with lower scores (i.e., B's and C's). From our present analysis and published studies, we can conclude that the male-dominated culture that marginalizes women may also originate in physics courses taken in high school and during the first semester of college.

The American Institute of Physics found that as the socioeconomic levels increased, so did the number of students enrolled in high school physics courses [50]. Put differently, secondary schools in low-income neighborhoods have fewer students taking physics courses. Riegle-Crumb and Moore [51] also found that students whose parents had higher levels of education were also most likely to be enrolled in physics courses. Recent work [Authors] has found that seeing oneself as a physics person is important for first-generation college students to develop an engineering identity. This work emphasizes a need to pay attention to how physics experiences shape students' engineering journeys. In light of the disadvantages minoritized students face in developing a physics role identity, some mechanisms can support students' views of themselves as physics people. For example, Hazari et al.'s [26] study found that pedagogical practices such as discussions about the relevance of science to everyday life, conversations about taking on a science identity, and encouragement to participate in science courses were positive predictors of developing a physics identity in high school. Evidence gathered from three thousand high school students who participated in an Active Physics curriculum found that these pedagogical practices especially helped female adolescents who had lower positive attitudes towards physics [52].

Lastly, women were less likely, in the present moment (*I see myself as an engineer now*), to see themselves as engineers and less likely to believe they can perform well in their engineering courses. There was no difference between men on their perceptions of their performance and belief in seeing themselves as engineers. We note that these students were surveyed at the beginning of their college careers and were unlikely to have formal engineering exposure. Yet, women had lower confidence in their abilities to succeed in engineering and a lower engineering role identity. This finding emphasizes the need to actively combat the gendered stereotypes and messages that students receive about engineering.

VII. Limitations

This study does not come without limitations. First, we understand some may find it problematic to compare groups across a baseline group (i.e., men continuing-generation college students). This decision was not taken lightly but was a result of a reflection of the reality that the majority of the engineering student body comprises of men who are not the first in their families to attend college. One can conclude that engineering continues to attract students with established strands that support identity formation. Therefore by triangulating these identity-forming mechanisms across students, we can identify ways of supporting marginalized students' identity development.

VIII. Conclusion

Our work examined differences in students' subject-related role identities in mathematics, physics, and engineering by gender and parental level of education. We found that physics role identity shows significant differences by both variables and that women had lower engineering competence beliefs and an engineering identity at the beginning of college. These results emphasize a need to pay attention to the types of messages, particularly in providing recognition opportunities in STEM that women receive. Our results also highlight the need to examine how the system of engineering may privilege those with inside knowledge about how it works and share similar identities to those for whom the system was designed to support. Engineering educators have an opportunity to disrupt the norms of engineering education to more equitably shape who pursues engineering pathways.

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