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Engineering Allies: The Personalities of Cisgender Engineering Students

Ms. Jacqueline Ann Rohde, Clemson University

Jacqueline Rohde is a senior undergraduate student in Bioengineering at Clemson University. Her research in engineering education focuses on the development student identity and attitudes with respect to engineering. She is a member of the National Scholars Program, Clemson University's most prestigious merit-based scholarship. She is also involved in efforts to include the Grand Challenges of Engineering into the general engineering curricula at Clemson University.

Dr. Adam Kirn, University of Nevada, Reno

Adam Kirn is an Assistant Professor of Engineering Education at University of Nevada, Reno. His research focuses on the interactions between engineering cultures, student motivation, and their learning experiences. His projects involve the study of student perceptions, beliefs and attitudes towards becoming engineers, their problem solving processes, and cultural fit. His education includes a B.S. in Biomedical Engineering from Rose-Hulman Institute of Technology, a M.S. in Bioengineering and Ph.D. in Engineering and Science Education from Clemson University.

Dr. Allison Godwin, Purdue University, West Lafayette (College of Engineering)

Allison Godwin, Ph.D. is an Assistant Professor of Engineering Education at Purdue University. Her research focuses what factors influence diverse students to choose engineering and stay in engineering through their careers and how different experiences within the practice and culture of engineering foster or hinder belongingness and identity development. Dr. Godwin graduated from Clemson University with a B.S. in Chemical Engineering and Ph.D. in Engineering and Science Education. She is the recipient of a 2014 American Society for Engineering Education (ASEE) Educational Research and Methods Division Apprentice Faculty Grant. She has also been recognized for the synergy of research and teaching as an invited participant of the 2016 National Academy of Engineering Frontiers of Engineering Education Symposium and 2016 New Faculty Fellow for the Frontiers in Engineering Education Annual Conference. She also was an NSF Graduate Research Fellow for her work on female empowerment in engineering which won the National Association for Research in Science Teaching 2015 Outstanding Doctoral Research Award.

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This research paper investigates how students who self-identify as cisgender might hold different personalities and engineering attitudes than students who identify as either male or female and do not identify as cisgender. These students may have a deeper understanding of diverse gender identities and may act as allies in an engineering context. A better understanding of these students provides insight into the types of students entering engineering that can help support and promote diversity. We used quantitative methods to analyze survey data from first-year engineering students relating to constructs of attitudes, personality, and engineering identity. The investigation revealed significant differences between students who identified themselves as cisgender and students who are presumed to be cisgender but do not explicitly identify themselves as such. Cis-identifying students were found to have stronger STEM-related identities and possess personality traits that made them more likely to accept and adopt certain social movements when compared to students who responded as male or female but did not label themselves as cisgender. These results inform a potential role for these students in helping students with minority gender identities to feel belonging within the engineering community. This work offers one of the first probes into nuanced gender identity in engineering education, particularly with teasing apart data that rises from the creation of inclusive demographic survey questions.

Introduction

The word “cisgender” is used to describe an individual who identifies with the gender that they were assigned at birth, serving as a contrast to transgender or other forms of gender identification (e.g., genderqueer, agender)[1]. In typical use, a female-born individual who currently identifies as female would label herself as a “cisgender woman,” often shortened to a “cis woman.” The use of cisgender as a descriptive label avoids the marked-unmarked dynamic in discussions of gender by preventing the classification of a portion of the population as normal and treating transgender or nonconforming gender identities as “Other” or aberrant[2]. A fitting analogy is heterosexual and homosexual identities describing sexual orientation. Although linguistically positioned as direct opposites, heterosexual and homosexual identities are but two orientations in a spectrum that includes asexual, bisexual, and pansexual, among others. Similarly, cisgender and transgender exist in harmony with other gender identities such as agender, genderqueer, or gender fluid. Creating multiple labels treats an identity as a continuum in which there are multiple valid options rather than a binary of man or woman[3].

The etymology of the use of cisgender as a descriptive label has been traced to DeFosse in 1994 and Buijs in 1996[1]. Green used both “cisgender” and “cissexual” in his 2006 discussion of the inclusion of trans individuals within the feminist movement, furthering the popularity of the term[4]. The relative novelty of cisgender signifies that the adoption and use in society at large is still developing. Additionally, the recent introduction of this terminology makes cisgender self-identification a marker for individuals who have a nuanced understanding of gender beyond the widely accepted binary of only male or female.

Cisgender identities have been studied in the fields of education and sociology, often through the lens of "cis-privilege," in which cisgender individuals are shown to experience certain unearned benefits over their transgendered counterparts[5,6]. These works often compare transgender or genderqueer individuals to cisgender individuals, where cisgender is used as a label for those who are non-trans or non-queer. Within education research, qualitative and quantitative work has explored the experiences of LGBTQ students within the classroom[7,8,9]. The field of engineering education has also addressed the social systems which may oppress non-gender-conforming students[10,11]. However, little focus has been turned to the nuanced gender identity, cisgender, which may be present among the majority population. Within engineering education, no work has examined differences between individuals who choose to voluntarily label themselves as cisgender and individuals who do not adopt a cisgender description of their identity. This paper serves as the first quantitative investigation into individuals who purposefully adopt and identify themselves as cisgender.

In this research project, we acknowledge that there are many reasons that an individual might not utilize "cisgender" to describe themselves—including ignorance, purposeful avoidance, or potential uncertainties about their gender. In a position in the privileged majority, some may see little reason to take on additional identity components. As such, this project chooses to direct focus towards the individuals who chose to use a cisgender label in responding to demographic survey questions. An individual might begin to utilize cisgender as an identifier through many pathways, including exploring their own gender identity, interests in social justice, or desires to be an informed ally. We hypothesize significant differences may occur between students who voluntarily add this descriptor to their gender identity when compared to students who are presumably cisgender but do not mark this option on a survey of their self-identified demographics.

Methods

The research draws from a larger study conducted at four large, public U.S. universities examining the attitudes of first-year engineering students and how these attitudes might affect their collegiate experience and the development of their engineering identity. The instrument measured student "STEM-related identities, personal motivations, grit, and personality"[12] in additional to expanded demographic information from traditional demographic data collected[13]. The development of this survey, including the theoretical framing, piloting, and deployment, was described previously[12]. This survey was administered to understand diverse attitudinal profiles and beliefs that first-year engineering students possess at the beginning of their collegiate career. The ongoing goal of this project is to understand how engineering context and culture may promote a singular, normative way of being an engineer and provide alternative ways to understand and support diverse attitudes and beliefs in engineering classrooms.

Attitudinal Factors

In this study, we examine differences in students' STEM identities, motivation, grit, and personality. These dimensions have a rich history in engineering education and provide a broad understanding of students' attitudes and beliefs. Our extensive survey measured a total of 23 factors of students' underlying or latent attitudes. These items were measured on an anchored 7-point scale[14]. Engineering, physics, and mathematics identity were measured through the constructs of recognition, performance/competence, and interest. These factors relating to STEM identities have been previously studied and have strong validity evidence for use[15,16]. Examining identity through these constructs has been shown as valid means to probe the extent to which students align themselves with specific STEM fields[15,16]. Students' agency beliefs, their feelings of empowerment to make change personally and globally, were also measured using Science Agency and Engineering Agency questions[17,18]. Belongingness items were used to measure the extent to which students felt that they belonged in the engineering community[19,20]. Motivation was measured using the frameworks of Goal Orientation and Future Time Perspective, including Performance Approach, Mastery Approach, Work Avoid, Expectancy, Connectedness, Instrumentality, Value, and Perceptions of Future[21,22]. Grit was measured through the factors of Persistence of Effort and Consistency of Interest[23]. Student personalities were measured through the "Big 5" personality traits—Neuroticism, Extraversion, Agreeableness, Conscientiousness, and Openness[24]. A summary of the factors measured is shown in Table 1.

Table 1. A summary of factors measured in the survey instrument used in this project. Shading provided for clarity.

Concept	Factor	Construct
STEM-related Identity and Agency[15,16]	Engineering Identity	Recognition
		Performance/Competence
		Interest
	Physics Identity	Recognition
		Performance/Competence
		Interest
	Math Identity	Recognition
		Performance/Competence
		Interest
	Science Agency[17,18]	
	Engineering Agency[17,18]	
	Belongingness[19,20]	
Motivation[21,22]	Performance Approach	
	Mastery Approach	
	Work Avoid	
	Expectancy	
	Connectedness	
	Instrumentality	
	Value	
	Perceptions of Future	
Grit[23]	Persistence of Effort	
	Consistency of Interest	
Personality[24]	Neuroticism	
	Extraversion	
	Agreeableness	
	Conscientiousness	
	Openness	

Demographic Questions

Within the survey demographics section, students were asked to report their gender identity with as many options as they felt appropriate to describe themselves. Students were given the option to respond as "female," "transgender," "male," "cisgender," "genderqueer," "a gender not listed," and/or "agender." The order in which the options are presented purposefully avoids treating minority gender identities as an afterthought[13,25]. The ability to select as many labels as appropriate prevents situations in which a respondent might have to choose between "Male" and "Transgender Male," a situation that can be alienating. Our approach also balances length with inclusion[13]. In this configuration, a woman who identifies with her biological sex would be able to select both "female" and "cisgender" to describe herself. If an individual's gender identity did not fall into the categories listed in the survey, they were prompted to write in their specific identity next to "a gender not listed." The phrasing of this item was crafted to treat write-in response as equally valid as the other options provided[13].

We defined two groups of gender identity responses for analysis. The first group, labeled as "cis-identifying" students, were individuals who responded as cisgender and either male or female. The second group, "cis-nonidentifying" students, responded as either male or female but did not respond as cisgender. These students are assumed to be cisgender (aligning with the gender assigned to them at birth), although they did not incorporate the term into their self-reported identity. We did not include individuals who responded as having other, non-cisgender identities or who only responded as cisgender without an additional male or female response. We chose not to include these students to focus on students who plausibly understood that both male or female and cisgender labels could be used to describe their gender identity and maintain an analysis focused on the explicit expression of cisgender identification in conjunction with a male or female response.

Analysis

The R programming language[26] was used to analyze potential differences between cisgender identified and cisgender nonidentified groups within the survey population. A Welch's t-test was used to test for differences in the averaged factor scores within for each group. In our data, the variance between groups was not equal, therefore a test that controls for unequal variance was used. A Welch's t-test is appropriate for testing between groups with unequal variance[27]. Effect size was calculated using Cohen's d to provide additional interpretation of the magnitude of the differences shown beyond statistical significance[28]. The ability to perform these analyses is dependent on assumptions of normality. Skew and kurtosis were examined to determine the appropriateness of normality assumptions. For each factor, we used the cutoffs of the absolute value of skewness less than 2.0 and kurtosis less than 7.0 to ensure that assumptions of multivariate normality were not severely violated[29,30].

Results

Descriptive Statistics of Cis-identifying and Cis-nonidentifying Populations

Of the 2916 students surveyed, 2697 identified themselves as male or female. Within the group that identified as either male or female, 55 students additionally identified themselves as cisgender. Two additional students identified as cisgender but did not specify themselves as male or female. These students were not included in the analysis because the theoretical conception of the term cisgender positions the term as entirely separate from male or female[1]. Analysis for this project was focused on the voluntary, explicit self-identification of cisgender individuals from a subpopulation that is implied to be cisgender. This implication is grounded in the vernacular use of solely "male" or "female" to describe a person who identifies with their gender assigned at birth.

Thirteen (23.6%) of the cis-identifying students identified themselves as female, while 42 (73.4%) of the students identified as male. In terms of racial and ethnic demographics, three of the students identified as Hispanic/Latino/Spanish Origin, 43 identified as White, four identified as Asian, and two identified as Black/African American. One cis-identifying student responded as having two racial or ethnic identities (White and Hispanic/Latino/Spanish Origin). Another cis-identifying student did not respond to the question asking students to identify their racial or ethnic identity. The number of responses for each racial/ethnic identity is included in Table 2 below, with percentages to provide an approximate representation of the groups. Please note that the number of responses is greater than the number of respondents, as several students reported multiple components to their racial/ethnic identity.

Table 2. Descriptive statistics of student self-reported gender identity and racial/ethnic identity.

	Cis-nonidentifying (n = 2911)		**Cis-identifying** (n = 55)	
Race/Ethnicity	**Count**	**%**	**Count**	**%**
American Indian	37	1.3	0	0
Hispanic/Latino/Spanish Origin	380	13.1	4	7.3
White	1852	63.6	44	80.0
Asian	410	14.1	5	9.1
Middle Eastern	32	1.1	0	0
Other	39	1.3	0	0
Black/African American	134	4.6	2	3.6
Pacific Islander	27	0.9	0	0

In terms of sexual orientations or sexualities, two cis-identifying respondents described themselves as bisexual, two described themselves as homosexual/gay/lesbian, and 47 described themselves as heterosexual. Four additional respondents considered themselves to be "a sexuality not listed" and were asked to describe their sexual orientation. These write-in responses were "Not sure," "heteroromantic demisexual," "pansexual," and "I honestly don't really care enough to examine it deeply." The number and proportion of these responses is found in Table 3.

Table 3. Descriptive statistics of student self-reported gender identity and sexual orientation.

	Cis-nonidentifying (n = 2673)		**Cis-identifying** (n = 55)	
Sexual orientation	**Count**	**%**	**Count**	**%**
Heterosexual	2601	97.3	47	85.5
A sexuality not listed	12	0.4	4	7.3
Homosexual/gay/lesbian	19	0.7	2	3.6
Bisexual	33	1.2	2	3.6
Asexual	8	0.3	0	0

Attributes of Cis-identifying Students

Analysis was conducted on the described factors, with a comparison between the cis-identifying and cis-nonidentifying populations. Save one, all factors met the requirements for skew and kurtosis to assume normality. To ensure that assumptions of normality have not been violated, the absolute value of the skew must be less than 2.0, while the kurtosis must be less than 7.0. The factor Mastery Approach was found to have a skewness of 2.47 and a kurtosis of 11.56. As these values indicated severe violations of normality, further analysis was not performed on the Mastery Approach factor. For all other factors, the skew ranged from -1.59 to 0.07 and the kurtosis ranged from 2.46 to 6.58. With assumptions of normality satisfied, we ran a Welch's t-test on the data.

A Welch's t-test revealed that the STEM identity measures were significantly different between cis-identifying and cis-nonidentifying students. The cis-identifying students, when compared to their nonidentified counterparts, reported higher physics identity scores across all three components: performance/competence beliefs (p = .001, Cohen's d = 0.41), recognition (p = .004, Cohen's d = 0.39), and interest (p = .001, Cohen's d = 0.39). Cis-identifying students also reported higher scores to the interest component of engineering identity (p = .035, Cohen's d = 0.24). Finally, the cisgender identified students reported higher beliefs in their Engineering Agency (p = .004, Cohen's d = 0.31) and in their Science Agency (p = .001, Cohen's d = 0.39).

There were also significant personality differences between cis-identifying and cis-nonidentifying students, as revealed by a Welch's t-test. Cis-identifying students were rated as higher on Openness from the "Big 5" personality measures (p = .006, Cohen's d = 0.40), and scored significantly lower on Conscientiousness from the "Big 5" personality measures (p = .028, Cohen's d = 0.34). The results of these comparisons are summarized in Table 4. For all of the differences found, the effect size was in the small to medium range which is consistent with education research[31]. The small to medium effect size can be interpreted as a 58% (Cohen's d = 0.2) to 69% (Cohen's d = 0.5) difference between the means of the two groups[32].

Table 4. Comparisons of cis-nonidentifying and cis-identifying students. P-values results are from a Welch's t-test. The effect size, from Cohen's *d,* can be interpreted as small for values of 0.2, medium for values of 0.5, or large for values of 0.80[32]. Bold font indicates the higher mean of the two groups.

Factor	Cis-nonidentifying Mean	Cis-identifying Mean	P-value	Effect Size	Description of Results for Cis-identifying
Engineering Identity: Interest	5.25	**5.50**	.035	0.244	Higher mean: increased interest in engaging in engineering[33]
Engineering Agency	5.51	**5.70**	.004	0.306	Higher mean: increased belief in ability to effect change through engineering[34]
Science Agency	4.90	**5.25**	.001	0.391	Higher mean: increased belief in ability to effect change through science[34]
Big 5: Conscientiousness	**3.40**	3.07	.028	0.343	Lower mean: less influenced by social expectations and norms[35-37]
Big 5: Openness	4.05	**4.44**	.006	0.404	Higher mean: increased acceptance of ideas or experiences unlike their own[36]
Physics Identity: Performance/ Competence	4.30	**4.80**	.001	0.418	Higher mean: increased belief in ability to successfully understand and do well in physics[16]
Physics Identity: Recognition	3.79	**4.32**	.004	0.390	Higher mean: increased feelings of being recognized as a "physics person"[16]
Physics Identity: Interest	4.66	**5.16**	.001	0.386	Higher mean: increased interest in engaging in physics[16]

Discussion and Implications

We acknowledge that interpretation from these data is constrained by certain cultural and linguistic barriers. The use of and need for the term "cisgender" is predominantly based in Western social trends, particularly in English-speaking countries[1]. Non-western cultures possess differing interpretation of gender, such that the student may not understand the term. Additionally, as cisgender is primarily used by English speakers, students who are not native speakers may not recognize the term even if they would agree to the label. We made the conscious decision to only place the term as an option rather than with an explanation of the meaning of the choice to identify students who understood what that label meant when selecting a response to the question. Additionally, no other responses in the demographics portion of the survey had explanations, and highlighting this one choice may alter the face validity of the survey. However, it is impossible to predict how many respondents would readily label themselves as cisgender if they understood the term.

These data show the differences between cis-nonidentifying and cis-identifying students. Higher scores for engineering identity constructs indicate that cis-identifying students see themselves as the kind of people who can be engineers and engage in engineering work. In addition to the higher scores on engineering identity and physics identity measures, these students more strongly believed in their agency to make change through science and engineering. Such responses indicate that students who voluntarily label themselves as cisgender feel more strongly like engineers when compared to other engineering students.

Additionally, higher Openness scores indicate that cis-identifying students are significantly more attentive to individuals' inner feelings and may seek out more variety in their experiences than their cis-nonidentifying peers. Lower Conscientiousness scores reveal that cisgender students, on average, are less likely to conform to traditional cultural norms. While the common use of "conscientious" implies an interpersonal component, the factor of Conscientiousness is associated with the traits of self-discipline, orderliness, and diligence[36]. Individuals who score high on Conscientiousness are more likely to be socially conforming[37]. As such, scoring low on Conscientiousness would relate to being more willing to engage in non-conforming social behavior. These personality dimensions are consistent with our interpretation that students who would self-identify as cisgender may be stronger allies in the engineering classroom.

When taken into account holistically, the results of this study indicate that cisgender self-identifying engineering students see themselves more strongly as engineers, feel empowered to make change, and are more open to new experiences. Students who express stronger engineering identity are more likely to persist and succeed within engineering[33]. Additionally, stronger science and engineering agency within students is related to predicting engineering as a career choice[34]. In other words, these quantitative data suggest that cis-identifying students are more likely to persist in engineering and attempt to change themselves or the world around them through the use of engineering. Meanwhile, lower Conscientious and higher Openness measurements reflect a lower need to conform to social norms and a greater acceptance of experiences unlike their own. Cis-identifying students are confident within engineering but are more likely to accept individuals who differ from themselves. Through an examination of cisgender engineering students, we have elucidated a group of students who could position themselves as changemakers within engineering culture for the benefit of minority populations.

When examining the experiences of minority students in engineering it is often noted that students are marginalized or treated differently because they do not reflect the cultural norms of engineering[9,20,38-40]. Allowing cis-identifying students to propose and implement change within the cultures of engineering may serve to reduce the ways in which the culture serves to isolate[9] and drive off those who are different from the norm[41]. Leveraging cultural change within engineering from a student-driven perspective may serve to overcome issues of buy-in for new ideas that faculty can face when working to change student attitudes and beliefs[42]. This idea of empowering students to become agents for change matches shared vision change models that have shown success in business and education environments[43]. The inclusion of agents (here, cis-identifying students) who may already feel empowered to make change in the decision making and implementation process of new initiatives only serves to increase the potential success of these initiatives.

Conclusions, Limitations, and Future Work

This work is a first exploration into understanding how cis-identifying engineering students may have different attitudes than their peers. The results of this work provide some insight into the types of students who understand what it means to be and identify as cisgender. The self-identification may indicate that these students have examined their own privilege related to their gender. These cis-identifying students, who have developed engineering and physics identities, may be particularly suited as allies in the classroom to support peers. These students, on average, also have a stronger preference for seeking out new experiences and going against social norms. We acknowledge that the data are cross-sectional in nature and causation cannot be determined from these differences. Students may mark a cisgender demographic because of their underlying attitudes, or students' underlying attitudes may influence an exploration of the cisgender label. Additionally, quantitative survey data does not translate in how likely students are to act on these attributes. Potential translation of survey response to action will be investigated through future research including qualitative interviews with respondents. Despite these limitations, our work provides evidence of differences in students' attitudes and can be used to better support inclusivity and diversity within the classroom.

Future research will work to understand these differences qualitatively to inform ways in which these individuals may serve as allies or "bridgers" for individuals within engineering who do not conform to gender and sexual orientation binaries. We have selected students from the survey who have non-traditional demographic measures, including gender identity to interview about their experiences in engineering, especially within teams. We believe that this qualitative work will allow us to answer deeper *how* and *why* questions about how engineering culture is shaped by peers in engineering and how diversity can become an integral part of engineering pedagogy.

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