

## **Does Endorsement of Masculine Ideals Predict Sense of Belonging and Identity over Performance and Peer interactions?**

### **Dr. Stephanie Butler Velegol, Penn State University**

Stephanie Butler Velegol is a Teaching Professor in Chemical Engineering at Penn State University. She pioneered the use of Flipped classes to increase active learning in the classroom and works on water treatment.

### **Katharine Getz, Penn State University**

Katharine Getz is a rising fourth year student at Penn State University studying chemical engineering and sexuality and gender studies. Katharine's research interests include the experiences of LGBTQIA+ students in engineering programs and the differences in belonging and the construction of resilience across students of different identities. She is looking to attend graduate school for engineering education.

### **Dr. Mechteld Veltman Hillsley, Penn State University**

Dr. Hillsley is a Teaching Professor in the Department of Chemical Engineering at Pennsylvania State University. She received a BS in Chemical Engineering from Virginia Tech in 1988 and an MS and PhD from Penn State in 1990 and 1994, respectively.

Does endorsement of masculine ideals predict sense of belonging and identity over performance and peer interactions?

## **Introduction**

As engineering students progress through their undergraduate education, they experience many challenges and hardships in their academic, personal, and social pursuits. Through these experiences, students develop an engineering identity. Research has been conducted to understand the development of the engineering identity in undergraduate students, with particular attention directed to factors that foster and hinder that development. For example, extending a model of identity developed on physics students, Godwin (2016) conceptualized engineering identity that derives heavily from competence and performance. While performance may be the critical and primary factor in the development of an engineering identity for students whose focus is on the tasks at hand, there are subgroups of students whose cognitive energy is directed to questions of belonging and inclusion in addition to performance. In fact, much social psychological theory and research has converged to show that a hallmark difference in the experiences of dominant group members – like white, cis-heterosexual, able-bodied man who is seen as the typical engineer – and marginalized group members, are the cognitive demands present in a situation (e.g., Schmader, Zhang, & Johns (2007)). For example, being targets of discrimination, being concerned about confirming negative stereotypes of one’s racial or gender group, and feeling belonging uncertainty all require cognitive attention that depletes executive function and has performance consequences. Therefore, it is reasonable to wonder if a conceptualization of engineering identity that is primarily performance-based may better capture the experiences of students who belong to dominant gender and racial groups than students who are members of marginalized gender and racial groups.

The development of the engineering identity for each student can be impacted by a variety of factors, and understanding these factors is essential for structural student support. In this paper, we are interested in what social factors correlate with Engineering Identity for chemical engineering students. However, because of the performance and competence focus of Godwin’s model, which we anticipate may accurately capture only the experiences of students of dominant gender and racial groups, we have expanded our conceptualization of Engineering Identity to include the scale for Collective Self-Esteem (CSE) as established by Luhtanen & Crocker (1992). This scale evaluates how students derive their self-worth from their group membership as a chemical engineer, connects more to social identity theory, and assesses how students identify as engineers rather than the strength of their engineering identity. The four subscales for Collective Self-Esteem include how students see themselves as a group member among chemical engineering students (Membership), how students see the group of chemical engineering students (Private), how students think others perceive chemical engineering students (Public), and how important being a chemical engineering student is to their identity (Identity).

To evaluate the correlation between belonging and the other scales, we selected an instrument that prioritizes student’s individual assessments of their “fit” to their social environment with the Sense of Social and Academic Fit by Walton *et al.* (2023). The scale evaluates how students feel understood, accepted, and valued within their environment to evaluate their subjective experience of belonging. It focuses on the connection of shared interests, beliefs, and experiences that students could share with their peers and the extent to which they feel they do.

Does endorsement of masculine ideals predict sense of belonging and identity over performance and peer interactions?

A student's social identity can be defined as "an individual's knowledge of belonging to certain social groups, together with some emotional and valuational significance of that group membership" (Ellemers 2019). We chose to evaluate this concept using the peer relations questions from established work regarding the welcoming nature of engineering culture and the role of peers (Davis *et al.* 2023). Informal group discussions within the department indicated that students felt their peers facilitated more judgement and served as a greater hindrance to belonging within the department than their instructors.

While gender disparities in engineering are a widely studied and cited phenomenon, there has been minimal investigation into the role of masculinity as a cultural ideology within engineering. By including a scale to evaluate Hegemonic Masculinity, or the idea that men should be all powerful, tough and nothing like women, we planned to explore the connections between the endorsement of that ideology and the sense of belonging and identity for students (Vescio and Schermerhorn 2021), (Thompson and Pleck 1995).

We are particularly interested in how chemical engineering students respond to all five of these instruments through the lens of gender and grade point average (GPA). Grade performance is an important factor considering the comparability of the performance between genders juxtaposed to the retention rates in chemical engineering (Burkholder 2023). Previous work has shown that cis-gender men report higher scores on engineering identity and belonging compared to women and non-binary students and that positive peer relations contribute to the strength of engineering identity with women expressing lower levels of those relations (Davis *et al.* 2023). Additional research has found that sense of belonging will be a greater predictor than GPA for engineering identity (Zabriskie, Henderson, and Stewart 2018).

We specifically hypothesized that:

1. There will be a significant difference between men and women for all five instruments with women showing lower engineering identity, belonging and views on hegemonic masculinity.
2. There will be a significant positive correlation between GPA and engineering identity, collective self-esteem and belonging and peer inclusion. (Students who perform better in school may be more likely to identify as engineers and feel like they belong.)
3. There will be a significant positive correlation between endorsement of Hegemonic Masculinity and scales measuring engineering identity and belonging.

## **Methods**

This research took place in the chemical engineering department at Penn State University (a large R1 University). The department typically graduates 150 – 200 students a year. Students were asked to fill out an IRB approved Qualtrics survey during the last week of the semester in Fall 2023 from three large chemical engineering classes that are typically taken by 2<sup>nd</sup> year, 3<sup>rd</sup> year and 4<sup>th</sup> year students as shown in Table 1. The students received extra credit for completing this survey and were given an alternative assignment to complete if they wanted the extra credit

Does endorsement of masculine ideals predict sense of belonging and identity over performance and peer interactions?

and didn't want to complete the survey. There were 110 students who identified as women and 147 who identified as men who filled out the survey. There were 4 students who did not chose woman or man as an identity. We did not include them in this analysis but will include them in the future.

In addition to the instruments described below, the students were asked to share demographic information such as their race, gender identity, sexual orientation, socio-economic status, if they are an international student and if they started at a satellite campus. We also asked them to share their GPA. This paper will focus on gender identity and GPA. Future papers will include other factors.

**Table 1: Number of students in each class that completed the survey. Total in Class is the number of students enrolled in the class.**

|                   | Typical Year | # of Women | # of Men | Total Completed | Total in Class |
|-------------------|--------------|------------|----------|-----------------|----------------|
| Material Balances | 2            | 49         | 53       | 102             | 105            |
| Fluids            | 3            | 31         | 57       | 88              | 96             |
| Kinetics          | 4            | 30         | 37       | 67              | 70             |
| Total/Average     | --           | 110        | 147      | 257             | 271            |

There were five instruments included in this study as summarized in Table 2. Students were asked to use a 7-point Likert scale from (1) strongly disagree to (7) strongly agree for all instruments included. Some had questions that used a reverse scale, but they were adjusted after data collection so that higher numbers correspond to stronger agreement. In other words, a higher score means students more strongly identify as engineers, feel like they belong and believe in masculine norms. All the questions for each instrument as well as the instructions for students are listed in Appendix A.

The original Collective Self-Esteem instrument uses social groups. Here we adjusted this instrument to indicate chemical engineering as the social group. Appendix B shows the exact changes that were made for this instrument. Note that this instrument has four subscales. The first one is **Membership** and this indicates if the subjects feel like they are a worthy or "good" member of the group. The second subscale is **Private**. This assesses the individual's perception of the worthiness of the group itself. The third subscale is **Public**, and this asks if others think the group is good. Finally, the fourth subscale, **Identity**, asks the importance of the group to the subjects' identity.

The Hegemonic Masculinity instrument also has subscales. Here we decided to only use two of the subscales in this instrument. The **masculine power & status** subscale indicates the need for men to achieve power and status. The **anti-femininity** subscale indicates that men should not pursue feminine activities and jobs. The last subscale, toughness, was not included in our study. This subscale looks at the expectation that men should be mentally, emotionally, and physically tough and self-reliant. Many of these questions relate to physical toughness and violence and we did not find this relevant to this study. We did include these questions in the Appendix if readers are interested in these questions.

Does endorsement of masculine ideals predict sense of belonging and identity over performance and peer interactions?

**Table 2: Instrument description including subscales, the number of questions and the reference. Some of the questions were reverse coded.**

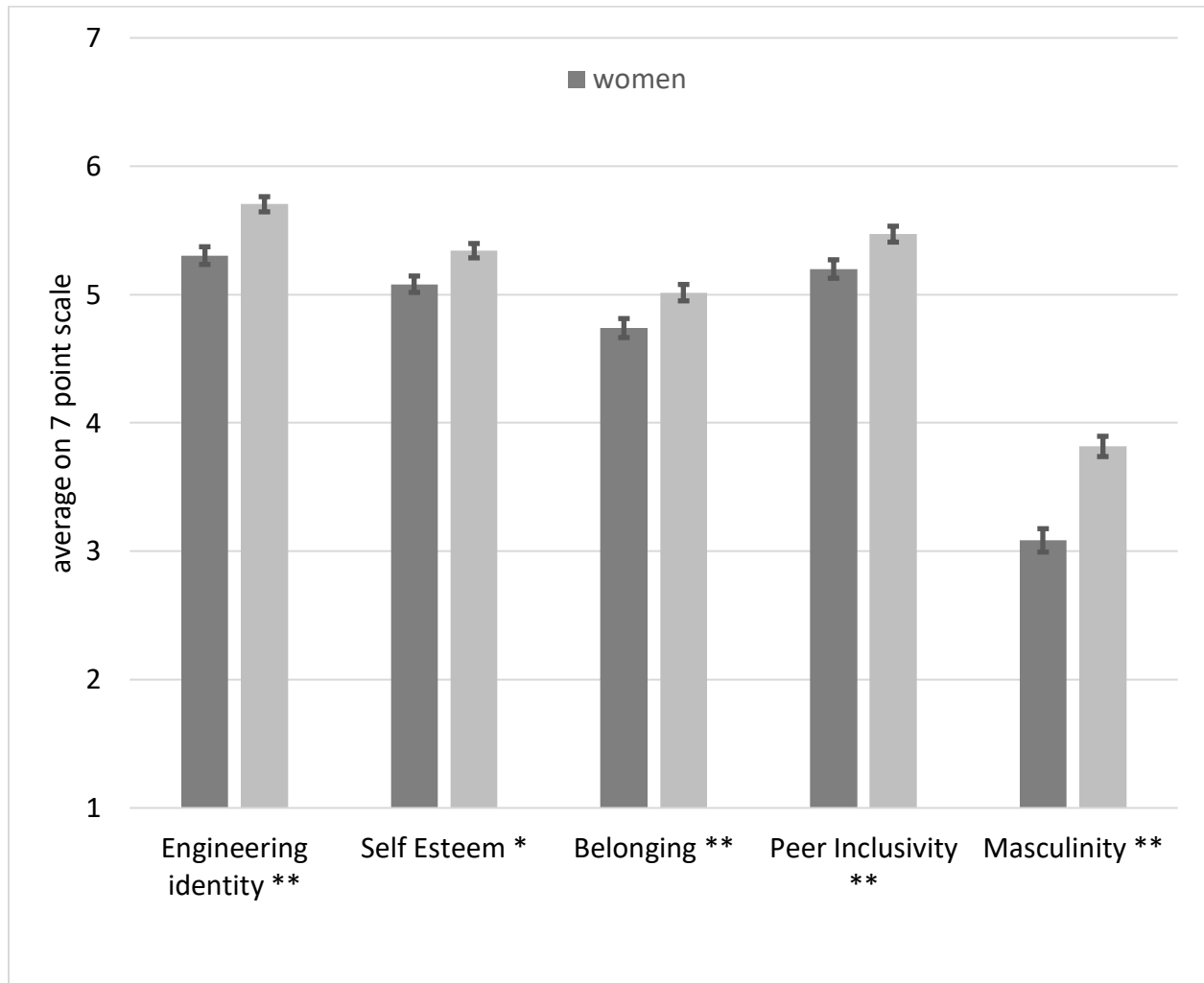
| Instrument name and subscales (if any)   | # of questions | reference   |
|--|----------------|---|
| Engineering identity (EI): Performance Based   | 13             | Godwin 2016   |
| Collective Self-Esteem (CSE) <ul style="list-style-type: none"> <li>- Membership (4) (I am a good ChE group member)</li> <li>- Private (4) (I think ChE is good)</li> <li>- Public (4) (Others think ChE is good)</li> <li>- Identity (4) (I identify as a ChE)</li> </ul>                         | 16             | Luhtanen & Crocker 1992   |
| Belonging: Sense of Social and Academic Fit  | 10             | Walton et al. 2023  |
| Peer Inclusivity: Connection to peer relations and engineering identity  | 10             | Davis et al. 2023   |
| Hegemonic Masculinity (HM) (e.g., masculine role norms) <ul style="list-style-type: none"> <li>- Masculine power &amp; status (11) (Men should be high in power and status)</li> <li>- Anti-femininity (7) (Men should not be feminine)</li> <li>- <del>Toughness Norm</del> (Not used)</li> </ul> | 18             | Vescio & Schermerhorn, 2021, as operationalized by Thompson & Pleck, 1986 |

The data was collected and imported into SPSS for analysis. Two types of analyses were done. To compare the results for women and men on all the scales, we used a t-test analysis of the difference of the means. Here we report if these differences are significant at the 0.01 level \*\* or the 0.05 level \* based on a 2-tailed test. Next, we were interested in any correlation between students' self-reported GPA and their responses to the five instruments and the subscales. To measure this, we used a Pearson Correlation in SPSS. We report the correlation as well as the significance at either a 0.01 level (2-tailed) \*\* or at a 0.05 level (2-tailed) \*.

## Results

We were interested in gender differences on instruments of engineering identity, belonging, peer relations, and views of masculinity. Figure 1 shows that there are significant differences between women and men on all five instruments. Note that these differences are at the 0.01 level for Engineering Identity, Belonging, Peer Inclusivity and Masculinity and at the 0.05 level for Collective Self Esteem. In general, both women and men scored above average on the Engineering Identity and Belonging scales with averages around five out of seven. The average values are lower for the Hegemonic Masculinity scale with averages in the middle between 3 and 4.

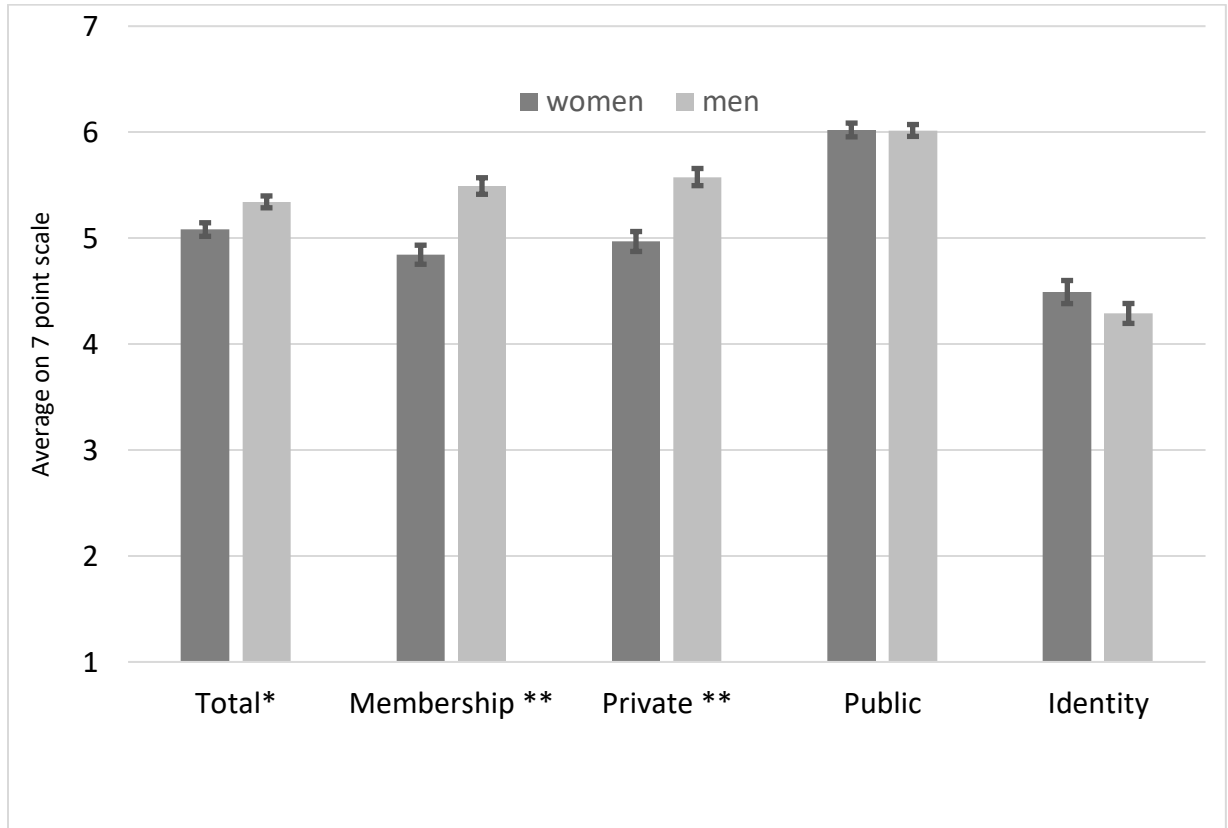
Does endorsement of masculine ideals predict sense of belonging and identity over performance and peer interactions?



**Figure 1: Average responses for each of the 5 instruments for Women vs. Men. Higher numbers mean more agreement with positive statements. A paired t-test was run on the averages and \*\* and \* indicate a 0.01 and 0.05 level confidence, respectively. Error bars represent standard error of the mean.**

We were further interested in looking at the subscales for Collective Self Esteem and Hegemonic Masculinity in relation to gender as shown in Figures 2 and 3. Interestingly, there are significant differences between women and men only for the Membership (i.e., I am a good chemical engineering group member) and Private scales (e.g., I think chemical engineering is good); compared to men, women felt they were less good CHE group members and personally valued CHE less. Their endorsement of Public (others think chemical engineering is good) or Identity (chemical engineering is an important part of my identity) subscales did not vary as a function of student gender.

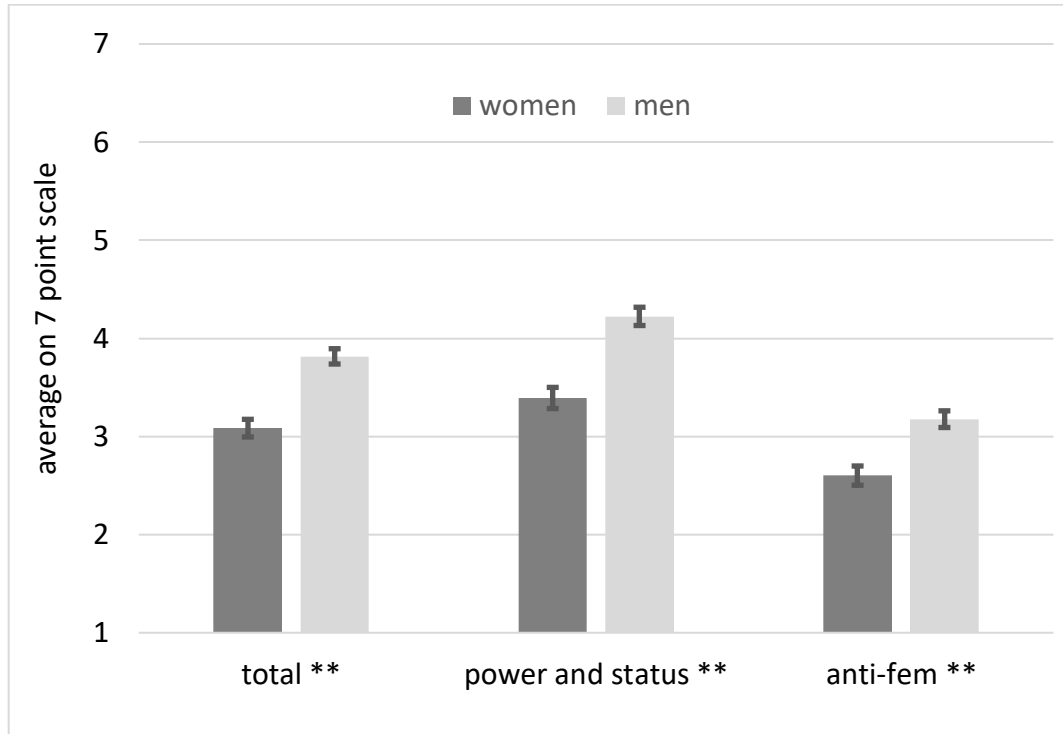
Does endorsement of masculine ideals predict sense of belonging and identity over performance and peer interactions?



**Figure 2: Average responses for the total and each subscale for the collected self-esteem instrument for Women vs. Men. Higher numbers mean more agreement with positive statements \* and \* indicate a 0.01 and 0.05 level confidence on a paired t-test. Error bars represent standard error of the mean. The subscales are defined in Table 2.**

Men more strongly endorsed both subscales of hegemonic masculinity than did women. Compared to women, men more strongly endorsed the notions that men should be high in power and status, while repudiating all that is feminine. It should be noted that the average for the anti-femininity is just above 3 for men and between 2 and 3 for women.

Does endorsement of masculine ideals predict sense of belonging and identity over performance and peer interactions?



**Figure 3: Average responses for the total and each subscale for the masculinity instrument for women vs. men. Higher numbers mean more agreement with positive statements \* and \* indicate a 0.01 and 0.05 level confidence on a paired t-test. Error bars represent standard error of the mean.**

Importantly, identity and masculinity, as well as belonging, have been suggested to be important predictors of engagement in and performance in STEM domains, including engineering. Therefore, we next estimated the correlations between Engineering Identity, the subscales of Collective Self Esteem (CSE), Peer Inclusivity, Belonging, the subscales of Hegemonic Masculinity and students' self-reported GPA for all 262 students. We see significant positive correlations between Engineering Identity, all the scales of CSE, Peer Inclusivity and Belonging. Note that the strongest correlations are between Engineering Identity and CSE: Member (I am a good group member), CSE: Private (I think chemical engineering is good) and Belonging (do they fit in CHE). There is no significant correlation between hegemonic masculinity and any other scale except a significant negative correlation with Peer Inclusivity. This means that students who have anti-feminine beliefs about masculinity are less likely to feel included with their peers.

We also see that GPA is significantly correlated (at the 0.05 level) positively with Engineering Identity, CSE member and Belonging and negatively correlated with the Power and Status subscale in Hegemonic Masculinity. This means that students who perform better in grades are more likely to identify as engineers, feel that they are a good group member and belong to the group. This also means that students with a lower GPA are more likely to believe that men should have power and status. Although these are significant, the correlations are all less than or equal to 0.160. In the next section, we will look at how these correlations change with gender.



Does endorsement of masculine ideals predict sense of belonging and identity over performance and peer interactions?

**Table 3: Pearson Correlations between Engineering Identity, the subscales of Collective Self Esteem (CSE), Peer Inclusivity, Belonging, the subscales of Hegemonic Masculinity and students' self-reported GPA for all 262 students. Pearson Correlations are significant at the 0.01\*\* level or 0.05\* level.**

|                    | Engineer Identity | CSE Member | CSE: Private | CSE: Public | CSE: Identity | Peer Inclusivity | Belong | HM: Power & Status | HM: Anti-fem | GP A |
|--------------------|-------------------|------------|--------------|-------------|---------------|------------------|--------|--------------------|--------------|------|
| Engineer Identity  | 1                 |            |              |             |               |                  |        |                    |              |      |
| CSE Member         | .683**            | 1          |              |             |               |                  |        |                    |              |      |
| CSE: Private       | .623**            | .650**     | 1            |             |               |                  |        |                    |              |      |
| CSE: Public        | .220**            | .230**     | .271**       | 1           |               |                  |        |                    |              |      |
| CSE: Identity      | .271**            | .197**     | .321**       | .263**      | 1             |                  |        |                    |              |      |
| Peer Inclusivity   | .436**            | .512**     | .444**       | .312**      | .152**        | 1                |        |                    |              |      |
| Belong             | .726**            | .659**     | .645**       | .316**      | .236**        | .611**           | 1      |                    |              |      |
| HM: Power & Status | .097              | .097       | .151*        | .014        | .079          | .044             | .119   | 1                  |              |      |
| HM: Anti-fem       | .061              | .045       | .046         | -.078       | .021          | -.175**          | .025   | .518**             | 1            |      |
| GPA                | .148*             | .134*      | .116         | .032        | -.016         | .135             | .135*  | -.160*             | -.003        | 1    |

Table 5 shows the same correlations as Table 4, but the women are at the top and right of the diagonal and the men are at the bottom and left. For women, there is no longer a significant positive correlation between CSE: Public (others think chemical engineering is good) and CSE: Member (I am a good group member) while for men it is significant at 0.309. That indicates that women who think others think chemical is good do not necessary think they are a good group member. There is also no longer a correlation for women between CSE:Public and peer inclusivity (people in chemical engineering respect and appreciate me.) while for men this is significant at 0.459. This means that men who think others think chemical engineering is good are more likely to feel respected by their peers, but this isn't true for women. There is also no longer a correlation for women between CSE: Identity (chemical engineering is a part of my identity) and peer inclusivity (others respect me) meaning that thinking chemical engineering is part of your identity doesn't correlate with being respected by others while this correlation is significant for men at 0.226.

Looking at Hegemonic Masculinity subscales compared to other scales, we can see that for women, there is no significant correlation between Hegemonic Masculinity and any of the other scales. This indicates that beliefs about masculinity don't influence their identity or belonging. For men, we see a significant negative correlation between Anti-Feminine beliefs and CSE: Public (others think chemical engineering is good) and Peer Inclusivity. This indicates that men

Does endorsement of masculine ideals predict sense of belonging and identity over performance and peer interactions?

who believe that men should not be like women are less likely to think that others view chemical engineering as positive and are less likely to be included with their peers.

Finally, we wanted to see how students' self-reported GPA was correlated with these scales along gender lines. Note that there is no significant difference between the reported GPA for men ( $3.47 \pm 0.45$ ) and women ( $3.47 \pm 0.36$ ). For women, there is a significant positive correlation between Engineering Identity and GPA but not for men. This means that women are more likely to identify as engineers with a higher GPA. This isn't surprising since this scale is performance-based scale. What is surprising is that it doesn't correlate with GPA for men. For women, we also note a significant positive correlation between GPA and Belonging. This also make senses because some of the belonging questions are performance based like "Compared with most other chemical engineering students at Penn State, I know how to do well in chemical engineering." and "Compared with more other chemical engineering students at Penn State, I am similar to the kind of people who succeed in chemical engineering." In addition, we see a significant negative correlation between GPA and Power and Status for women. This isn't a strong correlation, but it does means that a lower GPA in women is correlated with more agreement that men should have power and status. There is no correlation for men.

Although these gender differences are interesting and concerning, GPA is not significantly correlated with any of the CSE scales or peer inclusivity for either women or men. This means that even though there are difference in the scales for women vs. men, these differences are not accounted for from GPA alone. This indicates that there are other factors besides performance that could account for these differences.

Does endorsement of masculine ideals predict sense of belonging and identity over performance and peer interactions?

**Table 4: Correlations between Engineering Identity, the subscales of Collective Self Esteem (CSE), Peer Inclusivity, Belonging, the subscales of Hegemonic Masculinity and students' self-reported GPA 110 women (top and right of diagonal) and 148 men (bottom and left of diagonal). Pearson Correlations are significant at the 0.01\*\* level or 0.05\* level.**

|                   | Engineer Identity | CSE Member | CSE: Private | CSE: Public | CSE: Identity | Peer Inclusivity | Belong | HM: Power & Status | HM: Anti-fem | GPA     |
|-------------------|-------------------|------------|--------------|-------------|---------------|------------------|--------|--------------------|--------------|---------|
| Engineer Identity | 1                 | .614**     | .675**       | .238*       | .416**        | .300**           | .714** | -.017              | -.030        | .263**  |
| CSE Member        | .718**            | 1          | .590**       | .140        | .228*         | .420**           | .618** | .085               | -.022        | .161    |
| CSE: Private      | .508**            | .634**     | 1            | .273**      | .422**        | .311**           | .611** | .137               | .089         | .161    |
| CSE: Public       | .213**            | .309**     | .279**       | 1           | .404**        | .097             | .290** | -.023              | .055         | .045    |
| CSE: Identity     | .223**            | .226**     | .313**       | .130        | 1             | .079             | .296** | .087               | .154         | -.054   |
| Peer Inclusivity  | .515**            | .573**     | .515**       | .459**      | .226**        | 1                | .534** | .019               | -.0148       | .188    |
| Belong            | .705**            | .666**     | .631**       | .311**      | .205*         | .625**           | 1      | .011               | .016         | .190*   |
| HM:Power & Status | .003              | -.113      | -.030        | .007        | .117          | -.097            | .027   | 1                  | .452**       | -.199** |
| HM: Anti-fem      | -.022             | -.075      | -.145        | -.196*      | -.042         | -.351**          | -.128  | .475**             | 1            | .000    |
| GPA               | .083              | .127       | .096         | .011        | -.010         | .025             | .101   | -.157              | -.005        | 1       |

## Conclusion

At the beginning of this paper, we wondered if the performance-based identity was better able to capture the experiences of students who are in the dominant gender group. We measured this by comparing the Engineering Identity scale with the Collective Self Esteem Scale, a Peer Inclusivity scale, a Belonging scale, and a scale that measures beliefs in Hegemonic Masculinity. For this paper, we focused on differences in gender identity (women and men only) and differences based on GPA. Overall, we found that Engineering Identity has a significant positive correlation with all the other identity and belonging scales for both men and women, and we found no correlation between Engineering Identity and beliefs about Hegemonic Masculinity. We did find some other differences across gender and GPA lines as outlined below.

We first hypothesized that there would be differences along all scales for women and men with women showing lower identity, belonging and views of hegemonic masculinity. Our Figures 1 – 3 confirm this hypothesis. We specifically found that men scored higher than women on the performance-based Engineering Identity, Belonging, Peer inclusivity and both subscales of Hegemonic Masculinity. For the Collective Self-Esteem scale, we only saw differences in Membership (“I am a good group member”) and Private (“I think chemical engineering is good.”) but not on Public (“others think chemical engineering is good.”) and Identity (“chemical engineering a strong part of my identity.”).

Does endorsement of masculine ideals predict sense of belonging and identity over performance and peer interactions?

Our second hypothesis was that GPA would correlate with higher numbers for the Engineering Identity, Collective Self Esteem Scale, Peer Inclusivity scale and the Belonging scale. This would indicate that students who perform better based on grades would be more likely to identify as an engineering and feel like they belong. In fact, Table 4 shows that even though GPA did not correlate with any of the scales for men, we did see a significant correlation for women for the performance-based Engineering Identity and Belonging. Keep in mind that there is no difference between the GPA for men and women. Examples of questions that show that these are performance-based are: 1. "I can do well on exams in engineering." (EI), 2. I can overcome setbacks in engineering (EI), 3. "I think in the same way as do people who do well in chemical engineering at X University." (Belonging) 4. "Compared with most other students at X University, I know how to do well in chemical engineering." (Belonging). Future studies will investigate if this correlation holds with the non-performance-based questions as well.

Our final hypothesis was that there would be a significant positive correlation among all the five scales meaning that students who identify as engineers would also feel like they belong. Overall, we showed that there is strong correlation between the identity and belonging scales but is mostly insignificant for all four scales and the Hegemonic Masculinity scale. This means that strongly beliefs in Hegemonic Masculinity does not correlate with identity or belonging.

However, some of these correlations changed when broken down across gender lines. For example, there is no longer a correlation for women between their belief that others think chemical engineering is good and thinking they are a good group member and that they belong. Similarly, for women, there isn't a correlation between thinking chemical engineering is part of their identity and being included with others. This correlation is significant for men with a correlation of 0.459. Finally, we show that there is a strong significant negative correlation (-.351) for me between Anti-feminine views (Men shouldn't be like women.) and peer inclusivity (My peers respect me.). This indicates that men may not feel respected for these views.

Overall, we have shown significant differences between men and women on scales of engineering identity and belonging. For women, a higher GPA correlates with a higher Engineering Identity and Belonging possibly due to questions that are performance-based. There is no impact for GPA for men on any of the scales and that beliefs about Hegemonic Masculinity are not strongly correlated with most of the scales for women or men. In the future, we would like to compare more of these scales to other factors beyond GPA and gender, such as race, socio-economic status, international status, and membership in the LGBTQIA+ community.

Does endorsement of masculine ideals predict sense of belonging and identity over performance and peer interactions?

## References

- Burkholder, Eric. 2023. "Opportunity Gaps for Women in Chemical Engineering: A Quantitative Critical Investigation." Peer.asee.org. June 25, 2023. <https://peer.asee.org/opportunity-gaps-for-women-in-chemical-engineering-a-quantitative-critical-investigation>.
- Davis, Susannah C, Susan Bobbitt Nolen, Naeun Cheon, Elba Moise, and Eric William Hamilton. 2023. "Engineering Climate for Marginalized Groups: Connections to Peer Relations and Engineering Identity." *Journal of Engineering Education* 112 (2): 284–315. <https://doi.org/10.1002/jee.20515>.
- Ellemers, Naomi. 2019. "Social Identity Theory." In *Encyclopædia Britannica*. <https://www.britannica.com/topic/social-identity-theory>.
- Godwin, Allison. 2016. "The Development of a Measure of Engineering Identity the Development of a Measure of Engineering Identity." <https://par.nsf.gov/servlets/purl/10042227>.
- Luhtanen, Riia, and Jennifer Crocker. 1992. "A Collective Self-Esteem Scale: Self-Evaluation of One's Social Identity." *Personality and Social Psychology Bulletin* 18 (3): 302–18. <https://doi.org/10.1177/0146167292183006>.
- Perkins, Heather Lee, Allison Godwin, Edward J. Berger, and Justin Charles Major. 2022. "Potential of a Values Affirmation Intervention for Marginalized Gender Students' Belonging and Recognition." [www.researchwithrowan.com](http://www.researchwithrowan.com). August 23, 2022. <https://www.researchwithrowan.com/en/publications/potential-of-a-values-affirmation-intervention-for-marginalized-g>.
- Schmader, Toni, Michael Johns, and Chad Forbes. 2008. "An Integrated Process Model of Stereotype Threat Effects on Performance." *Psychological Review* 115 (2): 336–56. <https://doi.org/10.1037/0033-295x.115.2.336>.
- Thompson Jr, Edward H., and Joseph H. Pleck. "The structure of male role norms." *American Behavioral Scientist* 29, no. 5 (1986): 531-543.
- Vescio, Theresa K., and Nathaniel E. C. Schermerhorn. 2021. "Hegemonic Masculinity Predicts 2016 and 2020 Voting and Candidate Evaluations." *Proceedings of the National Academy of Sciences* 118 (2): e2020589118. <https://doi.org/10.1073/pnas.2020589118>.
- Walton, G. M., Logel, C., Peach, J., Spencer, S, & Zanna, M. P. (Accepted pending minor revisions). Two brief interventions to mitigate a "chilly climate" transform women's experience, relationships, and achievement in engineering. *Journal of Educational Psychology*.
- Zabriskie, C., R. Henderson, and J. Stewart. 2018. "The Importance of Belonging and Self-Efficacy in Engineering Identity." *AERA Open*, January. <https://par.nsf.gov/biblio/10058182-importance-belonging-self-efficacy-engineering-identity>.

Does endorsement of masculine ideals predict sense of belonging and identity over performance and peer interactions?

### Appendix A:

Questions from each of the five instruments used in this paper in the order presented here. All questions had a 7-point Likert scale.

| Strongly Disagree | Disagree | Somewhat Disagree | Neither Agree Nor Disagree | Somewhat Agree | Agree | Strongly Agree |
|-------------------|----------|-------------------|----------------------------|----------------|-------|----------------|
| 1                 | 2        | 3                 | 4                          | 5              | 6     | 7              |

**Collective Self-Esteem** Luhtanen, R., & Crocker, J. (1992). A Collective Self-Esteem Scale: Self-Evaluation of One's Social Identity. *Personality and Social Psychology Bulletin*, 18(3), 302–318. <https://doi.org/10.1177/0146167292183006>

According to social identity theory, social groups positively contribute to one's self-concept to the degree that one views the self as a "good"/prototypic group member, views the group positively, thinks others view the group positively, and the group defines how one sees the self.

The collective self-esteem scale includes the following our subscales:

1. **Membership:** Worthiness as a member of the group (1, 5, 9, 13), which assesses the degree that one views the self as a prototypic or "good" group member.
2. **Private:** Worthiness of the group (2, 6, 10, 14), which assesses how positively a person views their groups.
3. **Public:** Others' perceptions of the group (3, 7, 11, 15), which assesses perceptions of how others view one's ingroup.
4. **Identity:** Importance of the group to identity (4, 8, 12, 16), which assesses the importance or centrality of a group to one's sense of self.

#### Instructions:

We are all members of different social groups or social categories. Some social groups or categories pertain to gender, race, religion, nationality, ethnicity, and socioeconomic class. We earn our membership into other social groups, like professions and achievement based groups. We would like you to consider your memberships in those particular groups or categories and respond to the following statements on the basis of how you feel about those groups and your memberships in them. There are no right or wrong answers to any of these statements; we are interested in your honest reactions and opinions. Please read each statement carefully, and respond by using the following scale from 1 to 7:

1. I am worthy of being a chemical engineer.
2. I often regret that I chose chemical engineering.
3. Overall, chemical engineers are considered good by others.
4. Overall, being a chemical engineer has very little to do with how I feel about myself.
5. I feel I don't have much to offer chemical engineering.

Does endorsement of masculine ideals predict sense of belonging and identity over performance and peer interactions?

6. In general, I'm glad to be a chemical engineer.
7. Most people consider chemical engineers, on the average, to be more ineffective than other groups.
8. Being a chemical engineer is an important reflection of who I am.
9. I am a cooperative participant in groups of chemical engineers.
10. Overall, I often feel that being a chemical engineer is not worthwhile.
11. In general, others respect chemical engineers.
12. Being a chemical engineer is unimportant to my sense of what kind of a person I am.
13. I often feel I'm a useless member in groups of chemical engineers.
14. I feel good about being a chemical engineer.
15. In general, others think that chemical engineers are unworthy.
16. In general, being a chemical engineer is an important part of my self-image.

**Engineering Identity: Performance Based** Godwin, A. (2016). The Development of a Measure of Engineering Identity. *2016 ASEE Annual Conference & Exposition Proceedings*

Instructions:

To what extent do you agree or disagree with the following statements:

1. My parents see me as an engineer.
2. My instructors see me as an engineer.
3. My peers see me as an engineer.
4. I have had experiences in which I was recognized as an engineer.
5. I am interested in learning more about engineering.
6. I enjoy learning engineering.
7. I find fulfillment in doing engineering.
8. I am confident that I can understand engineering in class.
9. I am confident that I can understand engineering outside of class.
10. I can do well on exams in engineering.
11. I understand concepts I have studied in engineering.
12. Others ask me for help in this subject.
13. I can overcome setbacks in engineering.

**Belonging: Sense of Social and Academic Fit** Walton, G. M., Logel, C., Peach, J., Spencer, S., & Zanna, M. P. (Accepted pending minor revisions). Two brief interventions to mitigate a “chilly climate” transform women’s experience, relationships, and achievement in engineering. *Journal of Educational Psychology*.

Instructions:

Answer the following questions about what **chemical engineering** is like for you. Indicate the extent to which you agree or disagree with each statement using the scales below.

1. I belong in chemical engineering at Penn State University.
2. I feel comfortable in chemical engineering at Penn State University.
3. Other people understand more than I do about what is going on in chemical engineering at Penn State University.
4. I think in the same way as do people who do well in chemical engineering at Penn State University.

Does endorsement of masculine ideals predict sense of belonging and identity over performance and peer interactions?

5. It is a mystery to me how chemical engineering at Penn State University works.
6. I feel alienated from chemical engineering at Penn State University.
7. I fit in well in chemical engineering at Penn State University
8. Compared with most other chemical engineering students at Penn State University, I am similar to the kind of people who succeed in chemical engineering.
9. Compared with most other students at Penn State University, I know how to do well in chemical engineering.
10. Compared with most other chemical engineering students at Penn State University, I get along well with people in chemical engineering.

**Peer Inclusivity: Connection to peer relations and engineering identity.** Davis, S. C., Nolen, S. B., Cheon, N., Moise, E., & Hamilton, E. W. (2023). Engineering climate for marginalized groups: Connections to peer relations and engineering identity. *Journal of Engineering Education*

**Instructions:**

Please indicate how much you agree with each statement about interacting with **peers** in chemical engineering.

1. My chemical engineering peers respect my ideas.
2. In chemical engineering, people tend to ignore me.
3. Most of my chemical engineering peers are comfortable working with me.
4. It is too hard to work with people who do not share my home language.
5. I have friends in chemical engineering with whom I can really be myself.
6. Some of my peers think people like me should not be in chemical engineering.
7. Working in groups, I am able to influence our decisions.
8. I am not appreciated for the work I do in chemical engineering groups.
9. My chemical engineering peers often interact with me based on stereotypes.
10. I often socialize with chemical engineering peers outside of class.

**Hegemonic Masculinity** Thompson Jr, Edward H., and Joseph H. Pleck. "The structure of male role norms." *American Behavioral Scientist* 29, no. 5 (1986): 531-543.

Power and Status: questions 1 – 11

Anti-femininity: questions 12 – 18

Toughness scale questions were not used but are shown below question 18

**Instructions:**

Please indicate your agreement with each of the following statements.

1. Success in his work has to be man's central goal in this life.
2. The best way for a young man to get the respect of other people is to get a job, take it seriously and do it well.
3. A man owes it to his family to work at the best-paying job he can get.
4. A man should generally work overtime to make more money whenever he has the chance.
5. A man always deserves the respect of his wife and children.



Does endorsement of masculine ideals predict sense of belonging and identity over performance and peer interactions?

6. It is essential for a man to always have the respect and admiration of everyone who knows him.
7. A man should never back down in the face of trouble.
8. I always like a man who's totally sure of himself.
9. A man should always think everything out coolly and logically, and have rational reasons for everything he does.
10. A man should always try to project an air of confidence even if he really doesn't feel confident inside.
11. A man must stand on his own two feet and never depend on other people to help him do things.
12. It bothers me when a man does something that I consider "feminine."
13. A man whose hobbies are cooking, sewing, and going to the ballet probably wouldn't be my kind of guy.
14. It is a bit embarrassing for a man to have a job that is usually filled by a woman.
15. Unless he was really desperate, I would probably advise a man to keep looking rather than accept a job as a secretary.
16. If I heard about a man who was a hairdresser and a gourmet cook, I might wonder how masculine he was.
17. I think it's extremely good for a boy to be taught how to cook, sew, clean the house, and take care of younger children.
18. I might find it a little silly or embarrassing if a male friend of mine cried over a sad love scene in a movie

**Toughness scale questions below were not used in this study.**

1. When a man is feeling a little pain he should try not to let it show very much.
2. Nobody respects a man very much who frequently talks about his worries, fears, and problems.
3. A good motto for a man would be "When the going gets tough, the tough get going."
4. I think a young man should try to become physically tough, even if he's not big.
5. Fists are sometimes the only way to get out of a bad situation.
6. A real man enjoys a bit of danger now and then.

Does endorsement of masculine ideals predict sense of belonging and identity over performance and peer interactions?

## Appendix B: Changes to Collective Self Esteem Instrument

The original Collective self-esteem instrument uses social groups. We changed the social group to specify chemical engineering. The changes are highlighted below.

### Item Sample: General Items for Chemical Engineering Identity

1. I am worthy of being a chemical engineer. ~~member of the social groups I belong to.~~
2. I often regret that I chose chemical engineering. ~~belong to some of the social groups I do.~~
3. Overall, ~~my social groups~~ chemical engineers are considered good by others.
4. Overall, ~~my group memberships~~ being a chemical engineer has ~~have~~ very little to do with how I feel about myself.
5. I feel I don't have much to offer ~~to the social groups I belong to~~ chemical engineering.
6. In general, I'm glad to be a ~~member of the social groups I belong to~~ chemical engineer.
7. Most people consider ~~my social groups~~ chemical engineers, on the average, to be more ineffective than other ~~social~~ groups.
8. ~~The social groups~~ Being a chemical engineer I belong to are ~~is~~ an important reflection of who I am.
9. I am a cooperative participant in groups of the social groups I belong to ~~chemical engineers.~~
10. Overall, I often feel that ~~the social groups~~ being a chemical engineer ~~of which I am a member are~~ is not worthwhile.
11. In general, others respect ~~the social groups that I am a member of~~ chemical engineers.
12. ~~The social groups~~ Being a chemical engineer I belong to are ~~is~~ unimportant to my sense of what kind of a person I am.
13. I often feel I'm a useless member in groups of my social groups ~~chemical engineers.~~
14. I feel good about ~~the social groups I belong to~~ being a chemical engineer.
15. In general, others think that ~~the social groups I am a member of~~ chemical engineers are unworthy.
16. In general, ~~belonging to social groups~~ being a chemical engineer is an important part of my self-image.