Women and URM Experiences in Makerspaces

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Abstract

Academic makerspaces represent an ideal opportunity to present engineering students with active, experiential learning opportunities that reinforce theoretical concepts through conceptual design and prototyping. When appropriately supported, experiential learning in makerspaces has the capacity to drive development of technical skills and positive self-efficacy among novice engineers. However, research suggests that students who identify as part of historically underrepresented groups (i.e. those who are not White and male) can experience makerspaces in ways that marginalize their success. Thus, care must be taken in makerspace design and operation to create an environment that has a positive impact on the success of all students. In this study, we consider the perceptions and experiences of women and underrepresented racial/ethnic minorities (URMs) in an academic makerspace at one large, research intensive institution. We surveyed 256 undergraduate mechanical engineering students to compare and contrast their self-efficacy, their perceptions of makerspace support, and their peer-to-peer interactions. We found that student self-efficacy for conceptual design and prototyping did not differ by race or gender. However, females reported they were more likely to have a positive experience in the makerspace when supported by a teaching assistant who was also female. Students who identified as URM were significantly more likely to report discomfort in working with peers in the makerspace. We anticipate the outcomes of this study will provide implications for faculty and staff makerspaces at other postsecondary institutions who aim to build an inclusive and accessible learning environment for all students.

Introduction

The dominant culture in western engineering has been defined by White men from middle to upper class backgrounds [1]. While local and national efforts have been made on a large scale to diversify the engineering student population and change this culture, there is still a significant disparity in the number of STEM degrees awarded to women and other underrepresented minority (URM) groups [2-6]. Within postsecondary engineering programs of study, the predominance of White, males has been reported to create an atmosphere that is described as “chilly” for women and URMs who report high levels of discrimination and often experience stereotype threat [7-12].

At the same time as the environment of engineering departments is described as being detrimental to the success of minority groups, women and URMs often enter engineering programs with lower levels of self-efficacy and confidence - factors which are strongly tied to their retention in STEM [13-16]. Academic makerspaces represent an ideal opportunity to boost retention of these groups as these spaces have the potential to provide all students with active,

experiential learning that reinforces theoretical concepts learned in traditional courses and allows them to improve their self-efficacy and confidence for physical prototyping [17-21]. Recent research has shown, however, that the experiences of men, women and URMs in makerspaces can be radically different, even when care is taken in the design and operation of makerspaces in order to create an environment that has a positive impact on the success of all students [22-25].

Here, we consider the perceptions and experiences of women and URMs in an academic makerspace at one large, research intensive institution. Prior research at our institution [26,27] has indicated that women in particular typically enter the makerspace with low initial self-efficacy and/or confidence for conceptual design and prototyping, and that they may experience negative interactions with makerspace staff and other student users. Improved training of makerspace staff (usually peers who serve as teaching assistants) and students who use the space may be a potential pathway to mitigate these problems. These observations are consistent with the literature which points to the benefits of student-led makerspaces that foster peer-to-peer learning while cautioning against the drawbacks associated with a lack of makerspace staff training in how to interact with diverse users [28,29]. In several cases, research into the role of gender in makerspaces has found that women experience stereotype threat, harassment, and can feel unwelcome in such spaces [22-25,30].

In this study, we survey a large population ($n = 256$) of undergraduate mechanical engineering students who use our engineering makerspace. We compare and contrast the perceptions and experiences of women, URMs and the majority White male student population with the aim of addressing how, and under what conditions, women and URMs perceive and experience makerspaces differently. Our goal is to use empirical evidence to develop new policies and training protocols to improve the culture and climate within our makerspace for female and URM students. We anticipate the outcomes of this study will provide implications for faculty and staff makerspaces at other postsecondary institutions who aim to build an inclusive and accessible learning environment for all students.

Methodology

Data for this investigation were collected using an online survey instrument (Appendix A) that was distributed to undergraduate students using the makerspace in the fall of 2024. The survey population comprised mechanical engineering students ($n=256$) from their second to fifth years of study in the program. A total of 287 responses were recorded but 31 were removed as they were incomplete or otherwise unusable. Participant demographics are provided in Table 1. A total of 199 men and 54 women completed the survey, making up 78% and 21% of respondents respectively (women make up ~20% of the broader undergraduate student population in the department). The remaining 1% of respondents ($n=3$) identified as transgender or nonbinary. Thirty-two (32) subjects self-identified as URM (12% of responses) across the entirety of

participants (~15% of the wider undergraduate student population in the department identify as URM). Here we define URM status based on race/ethnicity (i.e., American Indian/Alaska Native, Black/African American, Hispanic/Latinx, Middle Eastern or North African, Native Hawaiian/Pacific Islander). We consider White and Asian students to comprise the majority since students from these groups account for approximately 85% of the undergraduate population.

Table 1. Demographics of Study Participants

Year of Study	Total	Male	Female	Transgender/Non-Binary	URM
Sophomore / 2nd	125	95	30	0	16
Junior / 3rd	103	85	15	3	9
Senior / 4th	28	19	9	0	7
Total	256	199 (78%)	54 (21%)	3 (1%)	32 (12%)

Survey items (Appendix A) considered participant demographics, questions regarding identity as a maker and self-efficacy for conceptual design and prototyping, and questions regarding interactions with both the makerspace teaching assistants (TAs) and other student users in the makerspace. Survey items came from a previously validated measure [26,27] with items related to self-efficacy in conceptual design and prototyping (i.e., "tinkering") with terminology relating to space identification [31]; The survey also included questions regarding participant interactions with makerspace staff (i.e., student teaching assistants or TAs) and their fellow students; these survey items were developed specifically for this study. Finally, we included two constructed response items for respondents to provide open ended comments regarding their perceptions of the culture of the makerspace, and any other feedback they had. All responses to the survey were anonymous. Prior to distribution of the survey, a discussion regarding its use and aims was held with the makerspace staff (student TAs).

Quantitative data were subjected to the following analytical methods. First, similar to the approach from a prior publication [26], Likert scale responses to the five-question tinkering self-efficacy section were aggregated into a single, continuous "tinkering score" (0-4 pt range). For each Likert scale survey item related to makerspace or peer interactions, a screening algorithm (Bootstrap Forest Method, JMP Pro 17) was applied to screen out independent variables (e.g., race, sexual orientation, gender) that did not affect the item outcome. For each independent variable that was a potential factor, the appropriate bivariate analysis was conducted, specifically, Chi-squared tests for categorical independent variables (gender or race) or logistic regression for continuous independent variables (GPA or Tinkering Score). Type I error of $p<0.05$ was considered the threshold for significance in all cases, and no post hoc adjustments were made for multiple comparisons. Cramér's V was calculated as a measure of

effect size where Chi-squared tests indicated significance ($V \leq 0.20$ = weak association; $V \geq 0.20$-0.40 = moderate association; $V \geq 0.40$ = strong association). For categories where the effect of gender was examined, only the male and female subject data was used as the population of transgender/nonbinary students is small ($n=3$).

Findings

Across the entire student population, perceptions of makerspace TAs were very positive, with over 80% positive response rates on all survey items in this category (Figure 1). A student's tinkering score was the factor most strongly related to their perceptions of makerspace TAs (logistic regression, $p<0.05$ for parameter estimate), with high scorers having more positive perceptions of TAs. Aside from tinkering scores, students' perceptions of makerspace TAs were not significantly associated with any other factors, including GPA, race, gender, sexual orientation, transfer student status, year-in-program, or being a TA oneself. For the study population, the tinkering score did not differ by race or gender (Chi-Sq $p>0.05$ for each bivariate comparison), nor was it correlated with GPA (Pearson's $r = -0.06$, $p>0.1$).

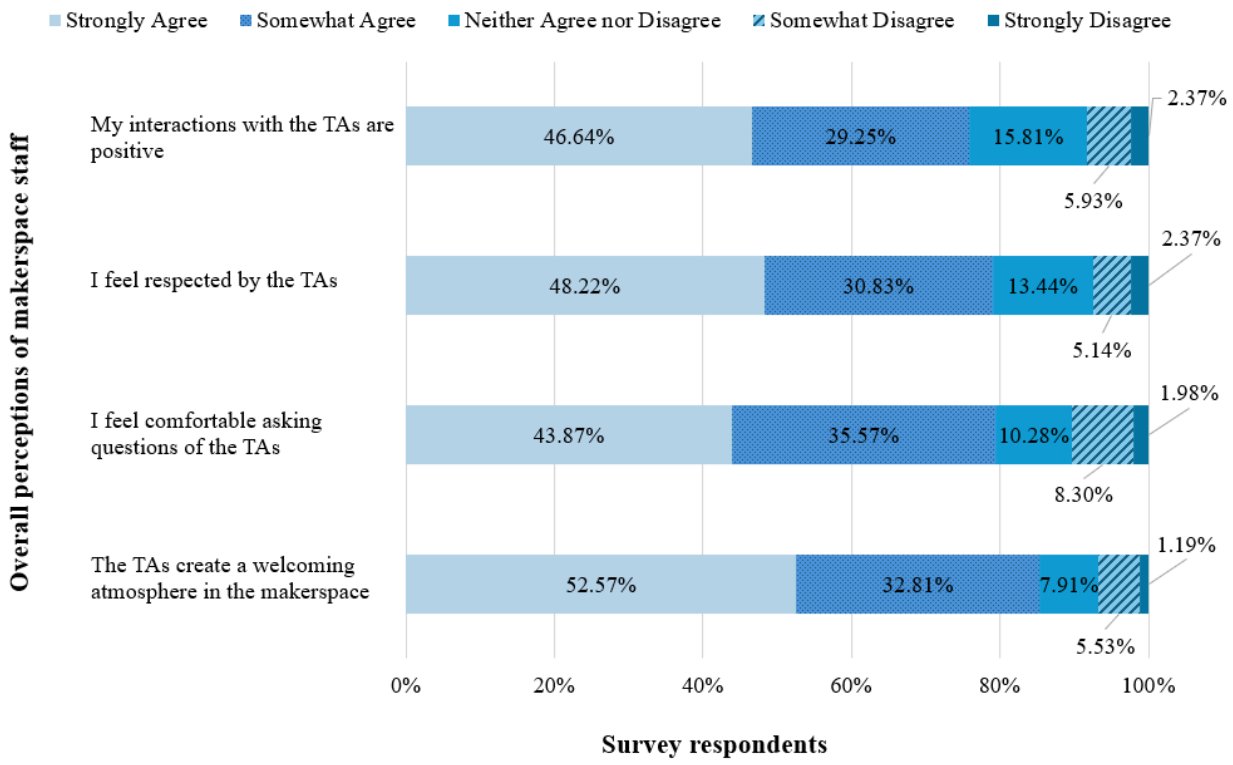

Figure 1: Overall perspectives concerning general interactions with the makerspace TAs (*n=253*).

Table 2. Comparison of Survey Responses by Gender (Male/Female)

Level of agreement with the following statements	Gender (Female/Male)	Strongly Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Strongly Disagree	Statistical Significance
I feel comfortable asking questions of the TAs.	F	48.15%	37.04%	7.41%	7.41%	0.00%	Chi Sq = 13.8, N=253, df=4, p=0.008, V=0.23
	M	53.77%	31.66%	8.04%	5.03%	1.51%	
My interactions with a Design Studio TA depend on the gender of the TA.	F	16.67%	29.63%	14.81%	11.11%	27.78%	Chi Sq = 54.04, N=253, df=4, p=<0.001, V=0.46
	M	3.02%	5.03%	13.57%	5.53%	72.86%	
I am more likely to have a positive experience with a TA who is the same gender as me.	F	22.22%	29.63%	29.63%	9.26%	9.26%	Chi Sq = 44.41, N=253, df=4, p=<0.001, V=0.42
	M	3.52%	9.05%	42.71%	10.05%	34.67%	
I feel that there is a good balance of genders among the Design Studio TAs.	F	12.96%	35.19%	29.63%	20.37%	1.85%	Chi Sq = 17.77, N=253, df=4, p=0.001, V=0.27
	M	31.16%	30.15%	30.65%	5.03%	3.02%	
I feel that there is a good mix of TAs from different racial/ethnic groups.	F	16.67%	12.96%	42.59%	24.07%	3.70%	Chi Sq = 12.24, N=253, df=4, p=0.016, V=0.23
	M	26.63%	25.13%	35.18%	9.55%	3.52%	
I have a fair number of classmates who share my background.	F	25.93%	31.48%	12.96%	16.67%	12.96%	Chi Sq = 17.69, N=251, df=4, p=0.001,V=0.26
	M	41.12%	38.07%	12.18%	5.58%	3.05%	
I feel comfortable working around my peers in the Design Studio.	F	50.00%	33.33%	3.70%	5.56%	7.41%	Chi Sq = 11.87, N=251, df=4, p=0.018, V=0.22
	M	56.85%	31.98%	8.63%	1.52%	1.02%	

Table 3. Comparison of Survey Responses by URM Status (Yes/No)

Level of agreement with the following statements	URM (Yes/No)	Strongly Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Strongly Disagree	Statistical Significance
My interactions with a Design Studio TA depend on the racial/ethnic background of the TA	N	1.36%	1.36%	14.93%	5.43%	76.92%	Chi Sq = 14.72, N=253, df=4, p=0.005, V=0.23
	Y	3.13%	12.50%	12.50%	9.38%	62.50%	
I have a fair number of classmates who share my background.	N	41.10%	37.90%	9.13%	7.31%	4.57%	Chi Sq = 22.11, N=251, df=4, p<0.001, V=0.30
	Y	15.63%	28.13%	34.38%	12.50%	9.38%	
I have classmates who support me in this major.	N	59.82%	27.40%	7.31%	3.65%	1.83%	Chi Sq = 17.69, N=251, df=4, p=0.001, V=0.26
	Y	37.50%	46.88%	15.63%	0.00%	0.00%	
I feel comfortable working around my peers in the Design Studio.	N	57.08%	31.96%	5.48%	2.74%	2.74%	Chi Sq = 12.61, N=251, df=4, p=0.013, V=0.22
	Y	43.75%	34.38%	21.88%	0.00%	0.00%	

Students reported that their interactions with makerspace TAs were affected by their own background as well as that of the TA (see Figure 2). Fewer than 5% of all respondents perceived that a TA's race or sexual orientation were factors in their interactions; however, nearly 25% of respondents felt that their interactions depend on a TA's gender. Compared to male students, females were found to be more likely to have interactions that depended on TA gender (*Chi Sq = 54.04, N=253, df=4, p=<0.001*); this finding had a strong association *(V=0.46*), and URM students were more likely to consider the racial/ethnic background of the TA as influential in their interactions (*Chi Sq = 14.72, N=253, df=4, p=0.005, V=0.24*). Table 2 compares male and female survey responses. Table 3 compares survey responses those from majority (White) students to those who identify from an underrepresented group.

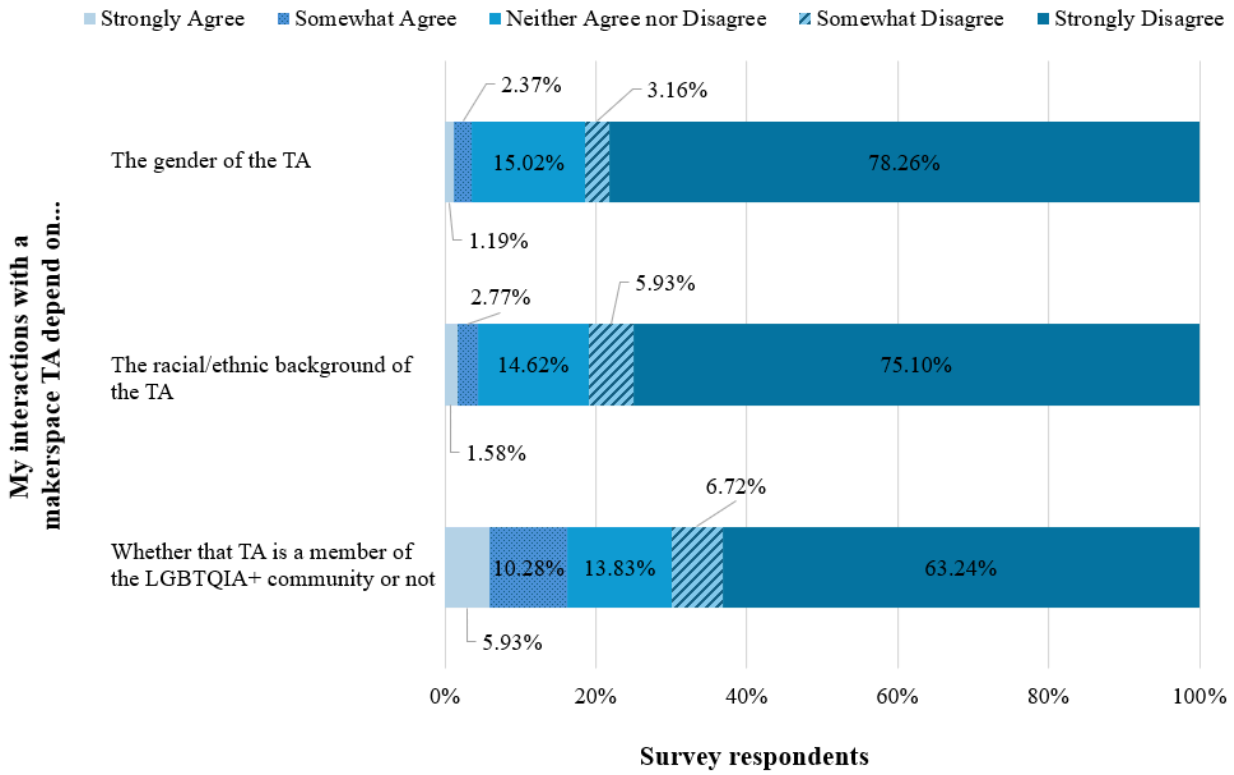

Figure 2: Students' perceptions of demographic factors affecting student-TA interactions. (*n=253*).

In general, students self-reported that they were more likely to have positive experiences with TAs who shared common characteristics with them (see Figure 3). In particular, women were more likely to have positive experiences with women TAs (*Chi Sq = 44.41, N=253, df=4, p=<0.001 V=0.46*), and were more likely to notice the gender (*Chi Sq = 17.77, N=253, df=4, p=0.001, V=0.27*) and racial/ethnic makeup (*Chi Sq = 12.24, N=253, df=4, p=0.016, V=0.22*) of the TAs. As a whole, however, students agreed that there was a good balance of genders and

racial/ethnic backgrounds among the TAs serving the makerspace. The diversity of our makerspace TAs is something to which we pay close attention; in fact, women and URM are overrepresented in our makerspace TA staff in relation to the student body as a whole. As such, these findings indicate that the choices we are making in terms of staffing are successful in some regards.

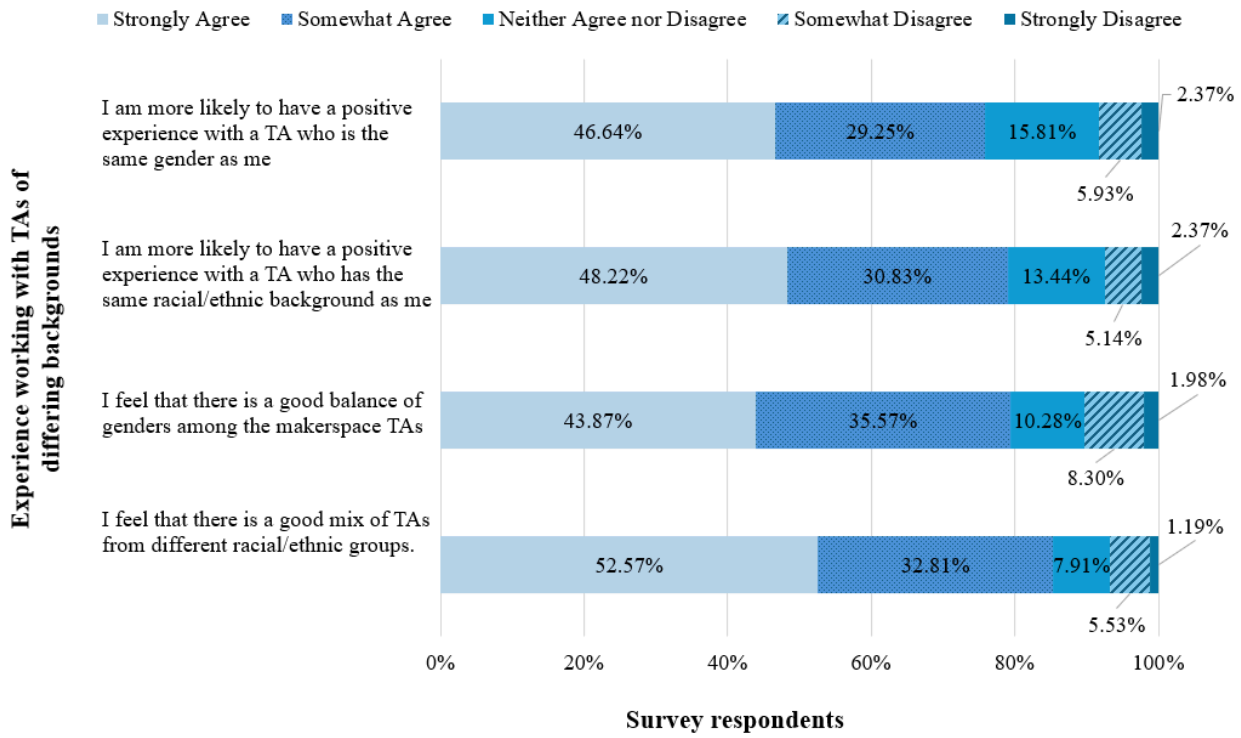

Figure 3: Students' perceptions of demographic factors affecting student-TA interactions. (*n=253*).

As shown in Figure 4, only a small percentage of students had either experienced or witnessed concerning behaviors from TAs; however, higher rates of concerning behaviors were seen among student users in the makerspace. When these responses based on behavior were broken down by gender, female students were more likely to have felt unsupported or ignored by a TA (*Chi Sq = 5.33, N=252, df=1, p=0.021, V=0.15*) and reported witnessing others being micromanaged (*Chi Sq = 4.51, N=252, df=1, p=0.034, V=0.17*). Female students were also more likely to have felt excluded from decisions made in group projects (*Chi Sq = 9.48, N=253, df=1, p=0.002, V=0.19*) and were more likely to have witnessed others being excluded (*Chi Sq = 20.20, N=253, df=1, p<0.001, V=0.28*). Comparison of male and female responses survey items related to exclusionary behaviors by others are shown in Table 4. Analysis of students identifying as LGBTQIA+ (*n=21*) also indicated a preference for working with students of a similar background (*Chi Sq = 16.32, N=253, df=4, p=0.038, V=0.25*, category not shown in Figure 3).

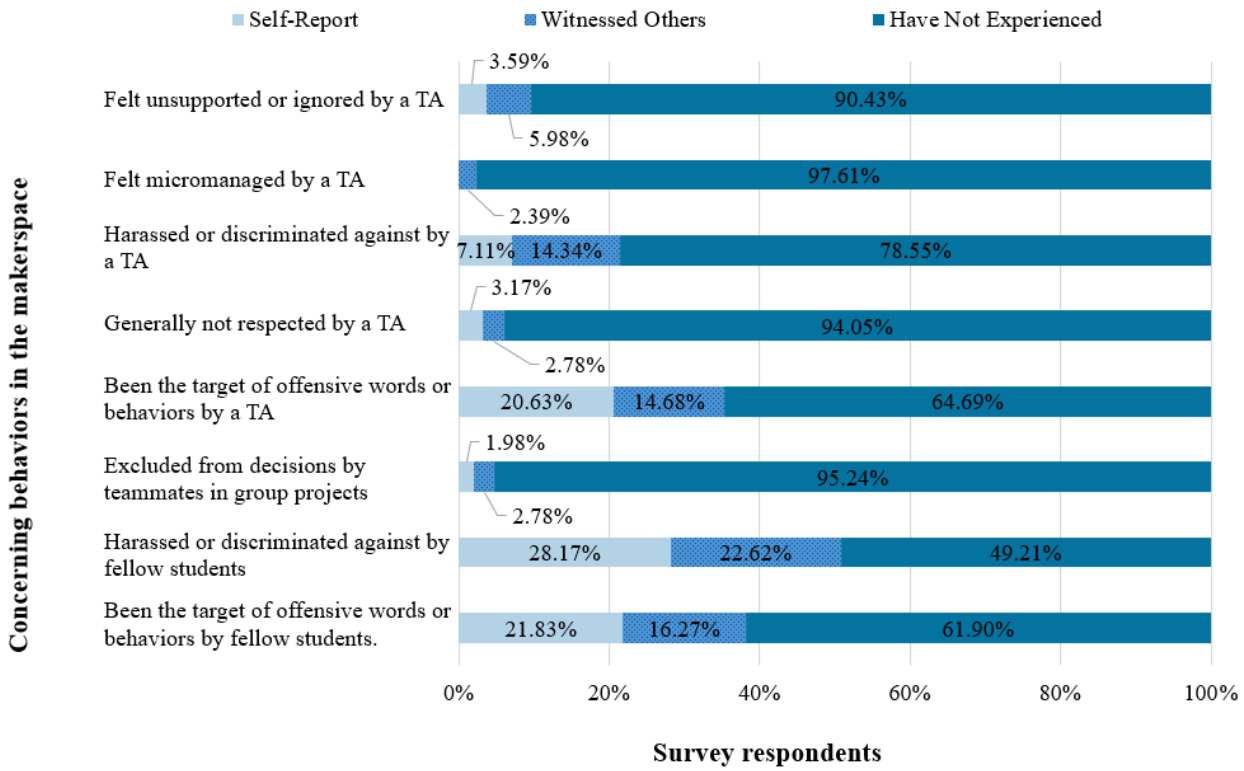

Figure 4: Examining whether participants have experienced or witnessed behavior in the makerspace (*n=253*).

Table 4. Comparisons by Gender (Male/Female) of Concerning Behaviors

Rates at which the following situations occur.	Male	Female	Statistical Significance
Personally felt unsupported or ignored by a TA.	18.69%	33.33%	Chi Sq = 5.33, N=252, df=1, p=0.021, V=0.14
Witnessed others being micromanaged by a TA.	19.70%	33.33%	Chi Sq = 4.51, N=252, df=1, p=0.034, V=0.13
Personally been excluded from decisions by teammates in group projects	4.52%	16.67%	Chi Sq = 9.48, N=253, df=1, p=0.002, V=0.20
Witnessed others being excluded from decisions by teammates in group projects	9.14%	33.33%	Chi Sq = 20.20, N=253, df=1, p<0.001, V=0.28

While less than a third of participants (n=79) elected to leave freeform comments on the survey, the comments that were left by women in particular highlighted the results seen in the analysis of Figure 4. Of the twenty (20) women who left comments on the survey, fifteen (15, or 75%) detailed negative interactions falling into one of the Figure 4 categories. The following examples (Quotes 1-3) are indicative of the general nature of these comments:

Not be watching like a hawk if I am the only woman in the shop.
Quote 1: Sophomore (2nd year) Female

It happened often that I felt uncomfortable [in] many areas in [the makerspace] as an Asian girl from a different country. Sometimes, I felt people don't even expect that I'm a MechE student because of my appearance even though I know how to use [the equipment]...
Quote 2: Senior (4th year) Female

As a female MechE I have been in groups before where my teammates do not listen to or respect what I have to say or contribute. They will brush me aside …
Quote 3: Senior (4th year) Female

The comments detailed in Quotes 1-3, along with the results displayed in Figure 3 and 4 and Table 3, are consistent with prior work detailing the experiences of female engineering students in a (White) male-dominated field [7-12].

Discussion and Implications

The results of this study indicate that the majority of our students experience no major concerns interacting with the TA staff who support our academic makerspace. Students with high self-efficacy in conceptual design and prototyping ("tinkering") are more likely to view their interactions with makerspace TAs as being positive. There is some indication that non-majority students (e.g., women, URMs, LGBTQIA+) may be more comfortable working with TAs who share their background, and that they may be more cognizant of diversity in the TA workforce. Although the occurrences were relatively rare, women experienced higher rates of concerning interactions from TAs, such as lack of support or micromanagement, that could exacerbate pre-existing disparities in self-confidence.

These findings may be specific to our particular academic makerspace, which is both a limitation of this study (not generalizable to other institutions) but also a strength because it may indicate why/how we are observing better than expected outcomes based on the literature survey:

- We have made a concerted effort to recruit and retain a diverse TA workforce. Women and URMs are actually overrepresented in the TA population as compared to the general student population.

- We make our community values explicit during TA training (e.g. no mansplaining, always be in “coaching” mode).
- Our study population did not include new makerspace users. All new users (i.e., first year students in their second semester) have individual design experiences that are aimed at boosting tinkering self-efficacy.
- The majority of faculty in our department are careful about not isolating women and minority students on teams, particularly in the early year classes.

In addition to these actions we have taken, the data presented here details the importance of maintaining a diverse TA workforce that believes in inclusive instructional practices. In theory, such a workforce can potentially be recruited and trained to be successful. It is less obvious, however, how the negative student-student interactions and issues with group dynamics observed in this work could be controlled. There is the potential to provide training in teamwork, as well as on inclusivity and other factors, to the entire student body, but it is more difficult to mandate or enforce these behaviors effectively without significant buy-in from both students and faculty. Future work at our institution is aimed at better understanding and evidencing the findings observed here, as well as generating best practices for training TAs supervising the makerspace.

Acknowledgements

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References

1. A. S. Bix, Girls coming to tech!: A history of American engineering education for women. MIT Press, 2014.
2. S. Cheryan, S. A. Ziegler, A. K. Montoya, and L. Jiang, “Why are some STEM fields more gender balanced than others?,” Psychol. Bull., vol. 143, no. 1, pp. 1–35, 2017.
3. B. L. Yoder, “Engineering by the numbers (2015),” American Society of Engineering Education (ASEE), 2015.
4. C. Sarah and L. K. Mona, “Critical mass theory and women’s political representation,” Polit. Stud., vol. 56, no. 3, pp. 725–736, Oct. 2008.
5. V. Valian, Why so slow?: The advancement of women. MIT Press, 1999.
6. National Science Foundation, & National Center for Science and Engineering Statistics (2019). Women, minorities, and persons with disabilities in science and engineering: 2019 Special Report NSF 19-304. , Issue. https://www.nsf.gov/statistics/wmpd.
7. Y. V. Zastavker, D. Chachra, C. Lynch, A. L. Sarang-Sieminski, and L. Andrea Stein, “Gender schemas, privilege, micro-messaging, and engineering education: practical lessons from theory,” in ASEE Annual Conference & Exposition, 2011.

8. J. Steele, J. B. James, and R. C. Barnett, “Learning in a man’s world: Examining the perceptions of undergraduate women in male-dominated academic areas,” Psychol. Women Q., vol. 26, no. 1, pp.46–50, Mar. 2002.
9. C. M. Steele, S. J. Spencer, and J. Aronson, “Contending with group image: The psychology of stereotype and social identity threat,” in Advances in Experimental Social Psychology, vol. 34, San Diego, CA: Academies Press, 2002, pp. 379–440.
10. Johnson, D. R. (2012). Campus racial climate perceptions and overall sense of belonging among racially diverse women in STEM majors. Journal of College Student Development, 53(2), 336–346. https://doi.org/10.1353/csd.2012.0028.
11. Lee, M. J., Collins, J. D., Harwood, S. A., Mendenhall, R., & Huntt, M. B. (2020). “If you aren’t white, Asian or Indian, you aren’t an engineer”: Racial microaggressions in STEM education. International Journal of STEM Education, 7(1), 1–16.
12. Godbole, A., Miller, B., Bothwell, M., Davis, S., Montfort, D., & Nolen, S. (2018). Engineering students’ perceptions of belonging through the lens of social identity. 1st Annual Conference of CoNECD Collaborative Network for Engineering and Computing Diversity.
13. D. Chachra and D. Kilgore, “Exploring gender and self-confidence in engineering students: A multi-method approach,” Cent. Adv. Eng. Educ. NJ1, 2009.
14. M. Besterfield-Sacre, M. Moreno, L. J. Shuman, and C. J. Atman, “Gender and ethnicity differences in freshmen engineering student attitudes: A cross-institutional study,” J. Eng. Educ., vol. 90, no. 4, pp. 477–489, Oct. 2001.
15. R. M. Felder, G. N. Felder, M. Mauney, C. E. Hamrin, and E. J. Dietz, “A longitudinal study of engineering student performance and retention. III. Gender differences in student performance and attitudes,” J. Eng. Educ., vol. 84, pp. 151–164, 1995.
16. M. Hartman, H. Hartman, and J. Kadlowec, “Gender across engineering majors,” in ASEE Annual Conference & Exposition, Honolulu, HI, 2007, p. 12.776.1-12.776.14.
17. Morocz, R. J., Levy, B., Forest, C., Nagel, R. L., Newstetter, W. C., Talley, K. G., & Linsey, J. S. (2016, June). Relating student participation in university maker spaces to their engineering design self-efficacy. In 2016 ASEE Annual Conference & Exposition.
18. Andrews, M. E., Borrego, M., & Boklage, A. (2021). Self-efficacy and belonging: The impact of a university makerspace. International Journal of STEM Education, 8, 1-18.
19. Brubaker, E. R., Kohn, M., & Sheppard, S. (2019). Comparing outcomes of introductory makerspace courses: The roles of reflection and multi-age communities of practice. International Symposium on Academic Makerspaces, New Haven.
20. Carbonell, R. M., Andrews, M. E., Boklage, A., & Borrego, M. (2019). Innovation, design, and self-efficacy: The impact of makerspaces. 125th ASEE Annual Conference & Exposition, Tampa.
21. Hilton, E. C., Talley, K. G., Smith, S. F., Nagel, R. L., & Linsey, J. S. (2020). Report on engineering design self-efficacy and demographics of makerspace participants across three universities. Journal of Mechanical Design, 142(10), 102301.

22. Schauer, A. M., Schaufel, H., & Fu, K. (2023). The makeup of a makerspace: the impact of stereotyping, self-efficacy, and physical design on women's interactions with an academic makerspace. Engineering Studies, 15(2), 122-143.
23. Capel, T., Ploderer, B., Brereton, M., & O'Connor Solly, M. (2021). The making of women: creating trajectories for women's participation in makerspaces. Proceedings of the ACM on human-computer interaction, 5(CSCW1), 1-38.
24. Roldan, W., Hui, J., & Gerber, E. M. (2018). University makerspaces: Opportunities to support equitable participation for women in engineering. Int. J. Eng. Educ, 34(2), 751-768.
25. Smit, D., & Fuchsberger, V. (2020, October). Sprinkling diversity: Hurdles on the way to inclusiveness in makerspaces. In Proceedings of the 11th Nordic Conference on Human-Computer Interaction: Shaping Experiences, Shaping Society (pp. 1-8).
26. Buckley JM, Grajeda S, Trauth AE, Roberts D. "A novel framework for quantifying student self-confidence and task choice in engineering design-related activities. ASEE Annual Conference and Exposition, Tampa, FL; 2019.
27. Trauth, A., Headley, M. G., Grajeda, S., Roberts, D., & Buckley, J. (2020, May). Individual Design Experiences Improve Students' Self-Efficacy on Team-Based Engineering Design Projects. In 2020 ASEE Virtual Annual Conference.
28. Eccles, Jacquelynne S. "Understanding Women's Educational And Occupational Choices: Applying the Eccles et al. Model of Achievement-Related Choices." Psychology of Women Quarterly 18, no. 4 (December 1, 1994): 585–609. doi:10.1111/j.1471-6402.1994.tb01049.x.
29. Eckhardt, Jennifer, Christoph Kaletka, Bastian Pelka, Elisabeth Unterfrauner, Christian Voigt, and Marthe Zirngiebl. "Gender in the Making: An Empirical Approach to Understand Gender Relations in the Maker Movement." International Journal of Human-Computer Studies 145 (January 2021): 102548. Doi:
30. Eveleth, Rose. "Computer Programming Used To Be Women's Work." Smithsonian Magazine, October 7, 2013. https://www.smithsonianmag.com/smart-news/computer-programming-used-to-be-womens-work-718061/.
31. Wittemyer, R., McAllister, B., Faulkner, S., McClard, A., & Gill, K. (2014). MakeHers: Engaging Girls and Women in Technology through Making, Creating and Inventing. Study by Intel Corporation.

Appendix A: Survey Instrument

Gender: How do you identify?

- [ ] Female
- [ ] Male
- [ ] Non-binary
- [ ] Transgender
- [ ] Prefer to self describe below
- [ ] Prefer not to say

Do you identify as part of the LGBTQIA+ community?

What is your age?

What is your race/ethnicity? Check all that apply.

- [ ] American Indian/Alaska Native
- [ ] Asian
- [ ] Black/African American
- [ ] Hispanic/Latinx
- [ ] Middle Eastern or North African
- [ ] Native Hawaiian or Pacific Islander
- [ ] White
- [ ] Choose to specify
- [ ] Prefer not to respond

Is English your first language?

- ( ) Yes
- ( ) No

What year are you in college?

- ◯ 1st year
- ◯ 2nd year
- ◯ 3rd year
- ◯ 4th year
- ◯ 5th year
- ◯ 6th year or more

Are you a transfer student?

- ◯ Yes
- ◯ No

Please indicate your anticipated GPA this semester

0 1 2 3 4

Anticipated GPA ☐ Not Applicable

Please indicate your overall undergraduate GPA

0 1 2 3 4

Overall GPA ☐ Not Applicable

Have you worked in the Design Studio as a TA (currently or previously)?

- ◯ Yes
- ◯ No

Rate how well each statement describes you.

	Not at all like me	Not much like me	Neutral	Somewhat like me	Very much like me
I have the knowledge and technical skills to create engineered designs.	○	○	○	○	○
I innately know how engineered systems work, like machines, electronics, or structures.	○	○	○	○	○
I have experience working with a variety of fabrication tools and equipment.	○	○	○	○	○
I have a history of tinkering on personal projects.	○	○	○	○	○
I can understand and utilize technical drawings and other design schematics.	○	○	○	○	○
I know what tools and equipment may be useful in creating a particular engineering design.	○	○	○	○	○

Think about your identity as a Maker. Which three (3) of the following terms do you most identify with?

- ☐ Builder
- ☐ Artist
- ☐ Hobbyist
- ☐ Creator
- ☐ DIY-er
- ☐ Engineer
- ☐ Maker
- ☐ Designer
- ☐ Tinkerer
- ☐ Innovator
- ☐ Inventor
- ☐ Crafter

When reflecting on the different work areas in the Design Studio, which work area(s) do you...

	Collaboration Suite	Woodshop	Fab Lab	Assembly Area	Machine Shop	Test Lab
Use the most?	☐	☐	☐	☐	☐	☐
Use the least?	☐	☐	☐	☐	☐	☐
Have the most interest working in?	☐	☐	☐	☐	☐	☐
Have the least interest working in?	☐	☐	☐	☐	☐	☐
Feel most comfortable using space, tools, & equipment?	☐	☐	☐	☐	☐	☐
Feel least comfortable using space, tools, & equipment?	☐	☐	☐	☐	☐	☐
Feel most comfortable asking for TA support?	☐	☐	☐	☐	☐	☐
Feel least comfortable asking for TA support?	☐	☐	☐	☐	☐	☐

What level of TA support do you utilize in each Design Studio work area listed below?

	About once a week	About once per month	1-2 times per semester	I do not use TAs in this work area
Woodshop	○	○	○	○
Fab Lab	○	○	○	○
Assembly Area	○	○	○	○
Machine Shop	○	○	○	○
Test Lab	○	○	○	○

Please indicate your agreement with the following statements concerning your general interactions with the Design Studio TAs.

	Strongly Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
My interactions with the TAs are positive.	○	○	○	○	○
I feel respected by the TAs.	○	○	○	○	○
I feel comfortable asking questions of the TAs.	○	○	○	○	○
The TAs create a welcoming atmosphere in the Design Studio.	○	○	○	○	○

My interactions with a Design Studio TA depend on...

	Strongly Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
The gender of the TA	○	○	○	○	○
The racial/ethnic background of the TA	○	○	○	○	○
Whether that TA is a member of the LGBTQIA+ community or not	○	○	○	○	○
Some other personal characteristic of the TA (describe)	○	○	○	○	○

Please indicate your agreement with the following statements concerning your interactions with the Design Studio TAs.

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I am more likely to have a positive experience with a TA who is the same gender as me.	○	○	○	○	○
I am more likely to have a positive experience with a TA who has the same racial/ethnic background as me.	○	○	○	○	○
I feel that there is a good balance of genders among the Design Studio TAs.	○	○	○	○	○
I feel that there is a good mix of TAs from different racial/ethnic groups.	○	○	○	○	○

(Optional) Please use this space to provide any additional comments you have regarding your interactions with TAs in the Design Studio.

(Optional) Please use this space to provide any additional comments you have regarding your interactions with TAs in the Design Studio.

Please state your level of agreement with the following statements about interactions with your UD MechE peers.

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I can relate to my classmates.	○	○	○	○	○
I have a fair number of classmates who share my background.	○	○	○	○	○
I have classmates who support me in this major.	○	○	○	○	○
In group projects, I feel that my teammates mostly respect me.	○	○	○	○	○
I feel comfortable working around my peers in the Design Studio.	○	○	○	○	○
I learn more from other students in the Studio than I do from the TAs.	○	○	○	○	○

Have you personally ever experienced any of the following in the Design Studio?

	Yes	No
Excluded from decisions by teammates in group projects	○	○
Harassed or discriminated against by fellow students.	○	○
Been the target of offensive words or behaviors by fellow students.	○	○

Have you witnessed another UD MechE student experiencing any of the following in the Design Studio?

	Yes	No
Excluded from decisions by teammates in group projects	○	○
Harassed or discriminated against by fellow students.	○	○
Been the target of offensive words or behaviors by fellow students.	○	○

(Optional) In your own words, how would you describe the culture and climate in the Design Studio?

(Optional) In what ways could we improve culture and climate in the Design Studio?