

A Baseline Analysis of Makerspace Engagement – Comparing Institutional and Demographic Factors for First Year Undergraduate Students

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Madhurima Das¹, George Moore², Elisa Bravo³, Amanda Baker⁴, Martin Culpepper⁵, Maria Yang⁶, Jesse Austin-Breneman⁷

¹Madhurima Das; Dept. of Mechanical Eng., MIT; e-mail: rimadas@mit.edu

²George Moore; Dept. of Mechanical Eng., MIT; e-mail: geomooore@mit.edu

³Elisa Bravo; Dept. of Mechanical Eng., University of Michigan; e-mail: ebravo@umich.edu

⁴Amanda Baker; Teaching + Learning Lab, MIT; e-mail: arbaker@mit.edu

⁵Martin Culpepper; Dept. of Mechanical Eng., MIT; e-mail: culpepper@mit.edu

⁶Maria Yang; Dept. of Mechanical Eng., MIT; e-mail: mcyang@mit.edu

⁷Jesse Austin-Breneman; Dept. of Mechanical Eng., University of Michigan; e-mail: jlab@umich.edu

Abstract

Makerspaces and maker-oriented experiences are on their way to becoming standardized components of our academic institutions. This growing expectation for access to makerspaces and maker-oriented experiences brings with it a sense of urgency to ensure that access is being provided to students of all backgrounds. In order to better understand the context that informs students' perception of makerspace access, this work examines early impressions of makerspaces engagement from first year undergraduate students. Specifically, this manuscript provides preliminary analysis of baseline data related to makerspace engagement from two institutions: a small, private R1 institution in the United States (Institution-A) and a large, public R1 university in the United States (Institution-B). Results highlight statistically significant institutional differences in students' intention to engage in a makerspace, perceived enjoyment, and perceived comfort in a makerspace. Also, assessment of survey results across demographic groups – such as gender identity – shows significantly different responses from students.

Introduction

Academic makerspaces are on the cusp of transitioning from an institutional luxury that supplements the student experience to becoming a standard facility in academic institutions. Many academic institutions now boast makerspace capabilities within their libraries in addition to where they may have previously been more common – such as their engineering departments and other STEM-focused silos of the institution [1]. With growing expectations for makerspace access to be extended to all students at these academic institutions, comes an increasingly urgent need to equip these spaces with the proper resources (tangible and intangible) to create safe and engaging spaces for students of all backgrounds to succeed.

Current experiences in makerspaces across most academic institutions are not optimal for all students – particularly when it comes to women and underrepresented

minorities (URM) [2-5]. Studies on inclusion in project-based learning highlight the importance of students experiencing agency, or a sense of control over their own actions and outcomes [6]. Women and URM students in engineering learning contexts may experience barriers to their sense of agency. For example, women students may perceive fewer opportunities for engagement in building prototypes while Black male students may feel like they must engage in proactive efforts to dispel negative stereotypes [7,8]. Inequities in students' experiences of agency could have downstream effects on their sense of belonging within engineering departments, their confidence in their ability to engage in engineering-related tasks (self-efficacy), their views of themselves as an engineer (engineering identity), and their mindsets toward failure.

The overarching goal of this project is to examine the experiences and perspectives of a diverse group of US undergraduate students as they engage in (or choose not to engage in) informal and formal makerspaces. Students' attitudes toward engineering (such as engineering identity, sense of belonging to engineering, and engineering self-efficacy), attitudes toward failure (such as fear of failure and openness to failure), and attitudes toward makerspaces (such as intention to engage in makerspaces, perception of makerspaces as enjoyable or useful, confidence in finding a makerspace, and comfort walking into a makerspace) are qualitative metrics used in the larger, longitudinal study that is associated with this work; however, only attitudes towards makerspaces are the focus of this manuscript. These data will be used to understand how makerspaces can be curated to optimally serve students from all backgrounds, including women, URM, and students with disabilities. With this goal in mind, we have framed the following research question: **RQ1** How does a student's institution and demographics influence their engagement with makerspaces – specifically, their intention to engage in makerspaces, perception of makerspaces as enjoyable or useful, confidence in finding a makerspace, and comfort walking into a makerspace?

Methods

A survey was distributed to all first-year students at a small, private R1 institution in the United States, referred to in this manuscript as “Institution A” or “I-A,” (n = 1,154) and first-year students enrolled in the College of Engineering at a large, public R1 university in the United States, referred to as “Institution B” or “I-B” (est. n = 1,010). Students were offered \$10 in the form of a credit to their student account (at I-A) or a Mastercard gift card (at I-B) for participating in the 10 min survey.

This manuscript focuses on engagement in makerspaces. Students’ engagement in makerspaces is measured by their Likert scale responses to survey items about intention to engage in makerspaces, perception of makerspaces as enjoyable or useful, confidence in finding a makerspace, and comfort walking into a makerspace. The Likert scale includes five options: strongly disagree, somewhat disagree, neither agree nor disagree, somewhat agree, and strongly agree. These items were examined based on institution and demographic characteristics.

All I-B students had already been admitted to the College of Engineering, suggesting an intention to pursue an engineering major. At I-A, students do not declare an area of study until their second year. Students participating in the survey were asked to indicate the major(s) that they planned to declare, then I-A students were grouped based on whether they selected at least one engineering major in order to provide a comparison group to the I-B sample.

The survey was also used to collect and compare self-reported demographic items, such as gender identity, sexual orientation, race / ethnicity, nationality, status as first-generation college students, estimated family income, plans to work during the academic year, and disability. Some of these demographics were re-coded to account for groups with small numbers of respondents and to create mutually exclusive groups for comparison. Because the samples at I-A and I-B were different demographically, demographic comparisons were conducted on the full sample and on each institutional sample separately, to assess whether demographic trends might differ meaningfully between institutions.

Results & Discussion

Of the 1,154 Institution A first-year undergraduate students, 432 participated in the survey (37.4% response rate). Of the estimated 1,010 Institution B first-year undergraduate students, 174 participated in the survey (est. 17.2% response rate). Tables 1(a) - 1(g) provide the demographic breakdown for survey responses from I-A and I-B. Results shared in Table 2(d) are in response to a “yes or no” survey item. For example, roughly 87% of students that took this survey, from both institutions, are not international students.

Table 1(a): Institutional comparison of survey results for self-reported gender identity demographics

Gender Identity	I-A n (%)	I-B n (%)
man	180 (42.1%)	87 (50.6%)
woman	230 (53.7%)	75 (43.6%)
non-binary, third gender, transgender (NTT)	18 (4.2%)	10 (5.8%)

Table 1(b): Institutional comparison of survey results for self-reported sexual orientation demographics

Sexual Orientation	I-A n (%)	I-B n (%)
Straight	299 (73.7%)	128 (78.1%)
Lesbian, Gay, Bisexual, Queer, Questioning (LGBQQ)	107 (26.4%)	36 (22.0%)

Table 1(c): Institutional comparison of survey results for self-reported race / ethnicity demographics

Race / Ethnicity	I-A n (%)	I-B n (%)
American Indian or Alaskan Native	6 (1.4%)	0 (0.0%)
Asian (Inc. Indian subcontinent and Philippines)	198 (47.3%)	74 (45.4%)
Black / African American	42 (10.0%)	3 (1.8%)
Hispanic / Latino/a/x	65 (15.5%)	15 (9.2%)
Middle Eastern	14 (3.3%)	7 (4.3%)
Native Hawaiian or Pacific Islander	6 (1.4%)	0 (0.0%)
White	153 (36.5%)	80 (49.1%)

Table 1(d): Institutional comparison of survey results for self-reported demographics about status as an international student or first-generation college student

Demographic	I-A n (%)	I-B n (%)
International Student	57 (13.5%)	23 (13.4%)

First Generation College Student	110 (26.6%)	24 (14.1%)
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Table 1(e): Institutional comparison of survey results for self-reported estimated family income demographics

Estimated Family Income	I-A n (%)	I-B n (%)
less than \$100,000	134 (37.2%)	44 (33.3%)
between \$100,000 and \$199,999	96 (26.7%)	54 (40.9%)
more than \$200,000	130 (36.1%)	34 (25.8%)

Table 1(f): Institutional comparison of survey results for self-reported gender identity demographics

Plans to work during academic year	I-A n (%)	I-B n (%)
No or maybe	224 (56.9%)	108 (62.8%)
Yes, under 10 hours per week	114 (28.9%)	29 (16.9%)
Yes, 10 or more hours per week	56 (14.2%)	35 (20.4%)

Table 1(g): Demographics and demographic categories included in baseline survey

Disability	I-A n (%)	I-B n (%)
Attention Deficit Hyperactivity Disorder (ADHD)	20 (5.2%)	5 (3.2%)
Autism Spectrum Disorder (ASD)	6 (1.6%)	1 (0.6%)
Learning disability	7 (1.8%)	2 (1.3%)
Chronic medical condition	10 (2.6%)	4 (2.6%)
Chronic mental health condition	31 (8.0%)	15 (9.6%)
Mobility disability / impairment	0 (0.0%)	0 (0.0%)
Visual impairment / low vision	16 (4.2%)	8 (5.1%)

Deaf / hard of hearing	1 (0.3%)	0 (0.0%)
Other disability or chronic health condition	6 (1.6%)	2 (1.3%)
None of the above	322 (83.4%)	124 (79.0%)
Selected one or more	64 (16.6%)	33 (21.0%)

Comparisons between I-A students and students at the I-B should be interpreted with caution, given that (a) students from the two institutions varied demographically and (b) the low response rate from students at I-B increases the likelihood of biased data if, for example, students who initially responded to the survey were more likely to be interested in engineering and makerspaces.

Further results are structured into the following two sections: Makerspace Engagement x Institution and Makerspace Engagement x Demographics.

Makerspace Engagement x Institution

To better understand students' engagement in academic makerspaces, their Likert scale survey responses were analyzed. Three institutional categories were used for these analyses – I-A non-engineering students, I-A engineering students, and I-B (engineering) students. Included in Table 2 are indicators that show which survey items received significantly different responses from institutional groups. Specifically, this table expresses the level of statistical significance associated with each survey item.

Table 2: Degree of statistical significance between institutional survey responses to items concerning makerspace engagement

Survey Prompt	Degree of Statistical Significance	Table Reference
“I plan on engaging in makerspaces outside of my classes”	***	Table 3
“Engaging in makerspaces sounds enjoyable to me”	***	Table 4
“Engaging in makerspaces sounds useful to me”	**	
“I know how to find one or more makerspaces on campus”	**	
“I would feel comfortable	***	Table 5

walking into a makerspace on campus”		
Note: Symbols indicate a statistically significant difference: 0.05 > *p > 0.01 > **p > 0.001 > ***p, m = marginally significant difference (0.1 > p > 0.05).		

These results suggest that students’ intention to engage in makerspaces, perceived enjoyment, and perceived comfort vary the most across institutions. Tables 3-5 show baseline survey results for each institution concerning items about makerspace engagement.

Table 3: Student’s intention to engage in makerspaces. Responses to the following prompt, “Within the next year, I plan on engaging in makerspaces outside of my classes”

	I-A non-engineering (n=61)	I-A engineering (n=333)	I-B (n=172)
Disagree	47.5%	15.0%	12.8%
Neither	9.8%	15.3%	24.4%
Agree	42.6%	69.7%	62.8%

Table 4: Student’s perception of makerspaces as enjoyable. Responses to the following prompt, “Engaging in makerspaces sounds enjoyable to me”

	I-A non-engineering (n=61)	I-A engineering (n=333)	I-B (n=172)
Disagree	29.5%	6.9%	6.4%
Neither	11.5%	8.1%	9.4%
Agree	59%	84.9%	84.2%

Table 5: Student’s perception of comfort in makerspaces at their institution. Responses to the following prompt, “I would feel comfortable walking into a makerspace on campus”

	I-A non-engineering (n=61)	I-A engineering (n=333)	I-B (n=172)
Disagree	44.3%	25.9%	27.3%
Neither	19.7%	13.9%	27.9%
Agree	36.1%	60.2%	44.8%

There was a highly significant difference ($p < .001$) in students' responses to survey items about intention to engage in makerspaces (Table 3), perception of makerspaces as enjoyable (Table 4), and perception of comfort in makerspaces (Table 5).

Table 3 depicts that students who are interested in engineering (admitted to the college of engineering at I-B or self-reported engineering major at I-A), are highly likely to plan on engaging in a makerspace outside of class. An intended major in engineering is correlated to high levels of agreement that makerspaces are enjoyable, as seen in Table 4. Notably, a major difference across the two institutions, shown in Table 5, is the comfort levels of students entering the makerspace. At I-A, students are much more comfortable entering makerspaces in comparison to I-B where the comfort level drops 15.4%. Future work will explore the possible factors that impact student’s perceived level of comfort in makerspace environments and how these factors are different across institutions.

Makerspace Engagement x Demographics

This section highlights baseline survey results for demographic groups that expressed significantly different responses concerning items about makerspace engagement. Demographic results are shared exclusively for each institution. Tables 6-8 highlight the differences in makerspace engagement at I-B. Gender Identity was observed as the demographic with the most statistical difference for this institution.

Table 6: Significant differences in I-B students’ intention to engage in makerspaces based on student demographics. Responses to the following prompt, “Within the next year, I plan on engaging in makerspaces outside of my classes”

	Gender Identity		
I-B (n=170)	men (n=85)	women (n=75)	NTT (n=10)
strongly disagree	1.2%	2.7%	–
somewhat disagree	10.6%	13.3%	–
neither	20.0%	32.0%	–
somewhat agree	30.6%	33.3%	40%
strongly agree	37.7%	18.7%	60%

Table 6 shows a marginally significant difference in the intention of cisgender men to engage in makerspaces than cisgender women. Cisgender women were found to be less likely to strongly agree that they plan to engage in makerspaces when compared on cisgender men. All nonbinary, transgender, and third gender (NTT) students indicated an intent to engage in makerspaces – these results should be interpreted with caution given the small sample size of this group (n=10).

Table 7: Significant differences in I-B students' perception of makerspaces as useful based on student demographics. Responses to the following prompt, "Engaging in makerspaces sounds useful to me"

	Gender Identity		
I-B (n=170)	men (n=85)	women (n=75)	NTT (n=10)
strongly disagree	1.2%	0.0%	–
somewhat disagree	3.5%	1.3%	–
neither	10.6%	12.0%	–
somewhat agree	41.2%	52.0%	–
strongly agree	45.5%	34.7%	100%

Table 7 demonstrates a greater proportion of cisgender men indicated that they strongly agreed whereas a larger proportion of cisgender women somewhat agreed. This suggests that there are differences in the degree to which cisgender men and cisgender women find makerspaces useful.

Table 8 : Significant differences in I-B students' level of comfort walking into a makerspace based on student demographics. Responses to the following prompt, "I would feel comfortable walking into a makerspace on campus"

	Gender Identity		
I-B (n=170)	men (n=85)	women (n=75)	NTT (n=10)
strongly disagree	1.2%	10.7%	–
somewhat	14.1%	33.3%	–

disagree			
neither	29.4%	25.3%	40%
somewhat agree	24.7%	20.0%	30%
strongly agree	30.6%	10.7%	30%

Table 8 demonstrates the differences in students' perceived comfort across gender identity at I-B. As shown in Table 5, I-B students feel less likely to be comfortable walking into a makerspace in relation to I-A students. Looking deeper into the data set, cisgender women from the I-B sample feel less comfortable walking into makerspaces than cisgender men. It was also found that cisgender women disagreed with the statement more (44%) than cisgender men (15.3%).

Next, Tables 9-10 highlight demographic differences in makerspace engagement at I-A. Statistically significant differences were observed across Race / Ethnicity and Sexual Orientation demographics at I-A.

Table 9: Marginally significant differences in I-A students' perception of makerspaces as useful based on student demographics. Responses to the following prompt, "Engaging in makerspaces sounds useful to me"

	Race / Ethnicity		
I-A (n=419)	White (n=153)	Asian (n=198)	URM (n=123)
strongly disagree	4.0%	0.6%	0.9%
somewhat disagree	10.1%	2.4%	3.4%
neither	8.1%	12.2%	10.2%
somewhat agree	31.3%	41.5%	36.4%
strongly agree	46.5%	43.3%	49.2%

Table 9 shows that similar proportions of students across Race / Ethnicity classifications at I-A agreed with the perception of makerspaces as useful; however, a greater proportion of White students disagreed with this perception, compared to Asian and URM students. Assessing the usefulness of a makerspace may involve a variety of different factors depending on the student. This result weakens the hypothesis that perceived utility in makerspaces has a positive correlation

with intention to engage in makerspaces. Given more statistical power, future work might consider why these factors are not correlated.

Table 10: Marginally significant differences in I-A students' level of comfort walking into a makerspace based on student demographics. Responses to the following prompt, "I would feel comfortable walking into a makerspace on campus"

	Sexual Orientation	
I-A (n=406)	LBGQQ (n=107)	Straight (n=299)
strongly disagree	12.9%	5.2%
somewhat disagree	23.8%	21.0%
neither	9.9%	16.2%
somewhat agree	29.7%	35.1%
strongly agree	23.8%	22.5%

Table 10 highlights that similar proportions of students across Sexual Orientation classifications at I-A agreed that they felt comfortable walking into makerspaces at I-A; however, a greater proportion of LBGQQ students disagreed with this compared to Straight students. This result reinforces the need to understand how responses from demographic groups may vary in volatility. In the case that more data provides statistical significance for this trend, it would be useful to consider how leaders within a makerspace might handle decision making for students that have a heightened sensitivity to the character of a makerspace.

Conclusion

This manuscript evaluates baseline survey results related to makerspace engagement for first year undergraduate students at a small, private R1 institution in the US, Institution A, and first year undergraduate students within the college of engineering at a large, public R1 university in the US, Institution B.

Responses to survey items about makerspace engagement indicate that students with an interest in engineering tend to have higher rates of intention to engage in a makerspace. Of the five survey items used to assess makerspace engagement, results indicate that intention to engage in makerspaces, perceived enjoyment, and perceived comfort as the major difference across the two institutions involved in this study.

This study also assessed makerspace engagement across several demographics. Gender identity proved to be a significant factor for makerspace engagement at I-B while

Race / Ethnicity and Sexual Orientation show marginal significance at I-A.

Future Work

This initial survey was sent out in the Fall of 2022. Since then, we have sent a follow-on survey in the spring to track students' actual engagement with makerspaces over the course of the year. Future work will explore institutional and demographic differences in actual engagement with makerspaces rather than just intentions for engaging with makerspaces.

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