

# *An exploration of the intersectional distribution of physical, social, and emotional resources in engineering*

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**Abstract** — This research paper explores intersectional (gender, race/ethnicity) differences in engineering students' access to physical (e.g., computers, books, etc.), social (e.g., prepared teachers), and emotional (e.g., caring peers) resources. The ability for students to access enriching and supportive resources may directly impact their interest and competence in STEM fields, which may, in turn, influence their pursuit of engineering careers. However, it is important to note that these resources are not equitably available to all students; access instead differs across gendered and racialized lines. Further, students at the intersections of racialized and gendered identities are likely to experience both forms of inequitable access separately and interactively, resulting in experiences with multiplicative inequalities. In this paper, we investigated variations in access to specific physical, social, and emotional resources of interest to our broader project using pilot data. To look at differences in resources across intersectional groupings, we used linear regression and observed both estimates and effect sizes. Our findings indicate that there are significant differences in Hispanic and Asian students' access to physical resources needed for study and practical work in comparison to dominant populations. These differences are further encapsulated by gender. Our findings also indicate that the same groups of students may not receive equitable emotional support. Our findings provide a nuanced understanding regarding some of the inequities faced by marginalized and minoritized students in engineering. Our future work further investigates the role of emotional resources in students' lives. Findings from this work and our future work will help researchers and practitioners better understand the issues faced by marginalized populations and provide potential solutions.

**Keywords**—*Gender, Race/Ethnicity, Intersectionality, Diversity*

## I. INTRODUCTION

Engineering education plays an essential role in providing students with the technical skills necessary to address global grand challenges [1]. However, the effectiveness of engineering education is significantly influenced by the availability of resources to students, including physical, social, and emotional

support [2]. The availability and quality of these resources may play a crucial role in shaping the educational experiences of engineering students, directly impacting their ability to innovate, solve complex problems, and prepare for the challenges of a global workforce. Without enough resources, students may find themselves at a disadvantage, lacking the essential tools, support, and opportunities needed to reach their full potential and contribute effectively to their respective field. Research indicates that access to these resources is not uniform, with disparities often observed along gendered and raced lines [3]. Disparities in access to resources may endanger our ability to meet the grand challenges of engineering.

Examples from the literature demonstrate the dangers of not addressing equitable access. One popular example can be seen by Foor et. al. [3]. Specifically, their low-income participant Inez, who did not have the same chances as others to prepare for college engineering courses, faced challenges amongst her engineering education [3]. Notably, the authors show how Inez did not have easy access to advanced math classes in high school or did not know about opportunities for internships. Inez thus started college at a disadvantage compared to peer students who had these opportunities. This example, one of many, demonstrates the importance of providing students equitable access to resources in engineering [3]. Other examples broadly include how some students might not have advanced classes in their high schools, like calculus, which may prepare students to advance their engineering knowledge [4], or how students might need to work a job to pay for school, taking time away from their ability to study [5]. Our negligence of issues of inequity in engineering endangers the future of the discipline. To address these gaps effectively, it is important that we explore how resources are distributed. Further, given the multiplicity of inequality, it is also important we explore issues of access across different intersections of race/ethnicity and gender.

## II. THEORETICAL FRAMING

Intersectionality Theory guides this work. Coined by Crenshaw [6], Intersectionality Theory provides a framework for understanding how overlapping oppressions, linked to identities including race, gender, and ethnicity, contribute to unique experiences of advantage or disadvantage. Per this theory, while women and individuals from minoritized racial identities may experience certain oppressions, a woman of color might face the same difficulties and more, not just because she is a woman or because of her race alone, but because of how related power structures interact with each other to create unique forms of oppression. In the context of engineering education, this intersectional lens illustrates that students at the confluence of marginalized racial and gender identities may face unique, compounded barriers to accessing resources [7]. The impact of resource disparities extends beyond academic performance, affecting students' sense of belonging, mental health, and, ultimately, their persistence in STEM fields [8], [9]. Despite growing recognition of issues of inequity, there remains a need for experimental research that explores how intersectional positionalities mediate the distribution of resources within engineering education. This study aims to fill this gap by investigating how physical, social, and emotional resources are distributed among engineering students across different race/ethnicity and gender intersections.

## III. METHODOLOGY

Using linear regression, we explore variations in student resource access. Our work builds on the basis of theories of intersectionality and resource distribution in educational contexts, aiming to contribute to insights for educators and policymakers committed to promoting equitable engineering learning environments. This study is part of a larger project investigating the “chosen families” of engineering students and the resources they receive from them. Chosen families are those family members students “choose” rather than those traditional families they are assigned at birth, emphasizing the significance of nonbiological connections in support networks [10], [2], [11]. In engineering, we find chosen families are peers, teachers, coworkers, or other important individuals in students' lives. We believe understanding what kind of resource access students have will help us better understand how their different families support them in and out of engineering contexts.

This Institutional Review Board (IRB) approved work was piloted at a mid-Atlantic public institution. We employed a random sampling technique to select participants. The survey was sent out to the entire engineering student body at the chosen institution. We sought engineering students who were 18 years of age or older and enrolled in engineering, engineering technology, or another engineering-related discipline. Surveys were collected using the online questionnaire platform Qualtrics. Our survey asked students to self-report their perceived access to different educational and non-educational resources via anchored scaling, including physical (e.g., access to specific items), social (e.g., access to specific interactions), and emotional (e.g., access to specific emotional supports). Constructs related to emotional support were adapted from, or created based on, the work of Gibson [12]. Similarly, some items related to physical and educational resources at home were

taken from the Educational Longitudinal Study of 2002 (ELS) [13], others we created ourselves. Finally, we collected students' demographics, including, but not limited to, race/ethnicity, gender, year, sexual orientation, and disability/ability status, using an inclusive survey design [14]. To encourage participation in our survey, we offered students a 10% chance to receive a \$5 gift card through the selected institution.

To analyze our data, we used linear regression via the software language R and RStudio. We used backward deletion to develop a parsimonious model. Our backward deletion of items was ordered via the following levels: 1) gender groupings, 2) race/ethnicity groupings, and 3) intersectional groupings. For intersectional efforts we created independent groupings rather than studying interaction effects. We sought to determine which gendered, racialized, and intersectional groupings were more or less akin to having access to certain physical, social, and emotional resources. In line with practices suggested by Mize [15], we used a cutoff of  $p < 0.05$  to identify significance for dominant populations (e.g., White men) and a less conservative cutoff of  $< 0.10$  for our nondominant populations. This feminist practice was enacted to ensure that we were not erasing marginalized knowledge amongst our predominately White and male sample [16]. We observed small ( $d < .2$ ), medium ( $d < .5$ ), and large ( $d > .8$ ) Cohen's  $d$  effect sizes to identify the most significant effects within our linear models [17]. We report on small, medium, and large effect sizes in this work.

Students' self-reported demographic information is summarized in Table I. Because students could choose more than one gender or racial/ethnic group, percentages may add up to more than 100%. Additionally, while students could pick from a variety of identifications of their gender identity that we did analyze differences in, for their protection, we have combined these identifications into a larger nonbinary category.

## IV. RESULTS

In this section, we describe our results in order of detailed tables of linear regression for different resources, including those that are emotional, social, and physical. To summarize our findings in advance, we find significant disparities in accessing resources for different intersectional race-gender groups.

Table II shows our final regressions for home physical resources. After completing regression, we found that Hispanic students were less likely to have access to physical resources, while White students were more likely to have access to physical resources. This access to resources also differed amongst intersectional race-gender groups. Hispanic students were more likely to have less access to physical resources, and the strength of these effects differed. Broken down, Hispanic students show less access to several physical resources: computers or laptops ( $\beta = -0.811$ ,  $d = 0.28$ ), DVD players ( $\beta = -5.509$ ,  $d = 1.01$ ), electric dishwashers ( $\beta = -3.689$ ,  $d = 0.50$ ), clothes dryers ( $\beta = -1.664$ ,  $d = 0.33$ ), owning 50 or more books ( $\beta = -2.053$ ,  $d = 0.26$ ), having their own room ( $\beta = -2.657$ ,  $d = 0.34$ ), and owning a phone ( $\beta = -1.657$ ,  $d = 0.29$ ). However, they showed more access to gaming consoles ( $\beta = 1.823$ ,  $d = 0.26$ ). Hispanic Women often showed less access to these resources than Hispanic men. For example, they showed less access to owning a television ( $\beta = -0.852$ ,  $d = 0.29$ ), a gaming Console ( $\beta = -4.591$ ,  $d = 0.60$ ), or one or more pets ( $\beta = -2.380$ ,  $d = 0.25$ ), but had more access to DVD

players ( $\beta = 4.000$ ,  $d = 0.66$ ). White students and other groups of students showed different levels of access to these resources. Specifically, White students showed more access to dishwashers ( $\beta = 1.533$ ,  $d = 0.32$ ) and one or more pets ( $\beta = 1.460$ ,  $d = 0.26$ ). Also, Asian students show less access to one or more pets ( $\beta = -3.509$ ,  $d = 0.47$ ). The most significant effect size among Hispanic students was observed in their access to DVD Players ( $d = 1.01$ ).

TABLE I. DEMOGRAPHICS OF THE SAMPLE (N = 56).

Grouping	Count	%
<b>Gender</b>		
Women	24	42.90%
Men	34	60.70%
Transgender	$\leq 5$	< 8.9%
NonBinary	$\leq 5$	< 8.9%
Did not disclose	1	1.80%
<b>Race/Ethnicity</b>		
American Indian	$\leq 5$	< 8.9%
Asian	7	12.50%
Black or African-American	$\leq 5$	< 8.9%
Hispanic, Latino, or Spanish origin	$\leq 5$	< 8.9%
Middle Eastern or North African	$\leq 5$	< 8.9%
White	44	78.60%
Did not disclose	1	1.80%
<b>Intersectional Grouping</b>		
Hispanic Women	$\leq 5$	< 8.9%
Hispanic Men	$\leq 5$	< 8.9%
Hispanic NonBinary	0	0.00%
Black Women	$\leq 5$	< 8.9%
Black Men	0	0.00%
Black NonBinary	$\leq 5$	< 8.9%
Middle Eastern Women	$\leq 5$	< 8.9%
Middle Eastern Men	0	0.00%
Middle Eastern NonBinary	0	0.00%
American Indian or Alaskan Native Women	$\leq 5$	< 8.9%
American Indian or Alaskan Native Men	0	0.00%
American Indian or Alaskan Native NonBinary	0	0.00%
White Women	25	44.60%
White Men	19	33.90%
White NonBinary	$\leq 5$	< 8.9%
Asian Women	$\leq 5$	< 8.9%
Asian Men	$\leq 5$	< 8.9%
Asian NonBinary	$\leq 5$	< 8.9%
NOTE: Sample sizes less than 5 (8.9%) have been redacted to protect our participants		

Table III shows our final regressions for socioeconomic attitudes. White women and Asian men students showed different levels of access compared to other groups. White women showed less access to money for eating outside of the home ( $\beta = 1.221$ ,  $d = 0.29$ ) and receiving very little beyond the basics of what they need ( $\beta = 0.822$ ,  $d = 0.29$ ). Asian Men showed less access, reporting less than White Women's access to money for eating outside of the home ( $\beta = 2.388$ ,  $d = 0.29$ ).

TABLE II. REGRESSION RESULTS FOR HOME PHYSICAL RESOURCES

Reg.	Est.	Error	t-value	p	Sig.	d
Q3a_1 = My household had a computer/laptop						
Hispanic	-0.811	0.376	-2.160	0.035	*	<b>0.28</b>
Q3a_3 = My household owned a DVD player.						
Hispanic	-5.509	1.356	-4.063	<0.001	***	<b>1.01</b>
Hispanic women	4.000	1.502	2.663	0.010	*	<b>0.66</b>
Q3a_4 = My household owned an electric dishwasher						
Hispanic	-3.689	0.772	-4.782	< 0.001	***	<b>0.50</b>
White	1.533	0.506	3.029	0.004	**	<b>0.32</b>
Q3a_5 = My household owned a clothes dryer						
Black	-2.864	0.812	-3.528	< 0.001	***	<b>0.37</b>
Hispanic	-1.664	0.530	-3.14	0.003	**	<b>0.33</b>
Asian	-0.697	0.489	-1.426	0.160		0.16
Asian Non-Binary	-4.167	1.213	-3.436	0.001	**	<b>0.39</b>
Q3a_6 = My household owned 50 or more books.						
Hispanic	-2.053	1.009	-2.035	0.047	*	<b>0.26</b>
Q3a_7 = I had my own room in my household						
Hispanic	-2.657	0.973	-2.731	0.008	**	<b>0.34</b>
Q3a_10 = My household owned a phone.						
Hispanic	-1.657	0.514	-3.227	0.002	**	<b>0.29</b>
Asian Men	-1.357	0.569	-2.386	0.021	*	<b>0.29</b>
Q3a_11 = My household owned a television.						
Hispanic Women	-0.852	0.372	-2.292	0.026	*	<b>0.29</b>
Q3a_12 = My household owned an air conditioner.						
Asian Men	-1.241	0.515	-2.408	0.019	*	<b>0.31</b>
Q3a_13 = My household owned a heater.						
Asian Men	-0.620	0.284	-2.183	0.033	*	<b>0.28</b>
Q3a_14 = My household owned a gaming console.						
Hispanic	1.823	1.76	1.036	0.305		<b>0.26</b>
White	1.363	0.566	2.410	0.019	*	<b>0.30</b>
Hispanic Women	-4.591	1.888	-2.432	0.018	*	<b>0.60</b>
Q3a_15 = I owned one or more pets.						
Asian	-3.509	0.900	-3.901	< 0.001	***	<b>0.47</b>

White	1.460	0.745	1.960	0.055		<b>0.26</b>
Middle Eastern Women	-4.015	1.856	-2.164	0.035	*	<b>0.21</b>
Hispanic Women	-2.38	1.01	-2.337	0.023	*	<b>0.25</b>
Q3a_16 = I owned name-brand clothes.						
Hispanic Men	-4.246	2.047	-2.074	0.043	*	<b>0.27</b>
Sig. $p < 0.10$ ".", $p < 0.05$ "**", $p < 0.01$ "***", and $p < 0.001$ "****"						

TABLE III. REGRESSION RESULTS FOR SOCIOECONOMIC ATTITUDES.

Reg.	Est.	Error	t-value	p	Sig.	d
Q3b_3 = My household regularly sold personal possessions to make ends meet.						
Male	-0.608	0.360	-1.687	0.097		<b>0.21</b>
Black	2.226	0.966	2.303	0.025	*	<b>0.29</b>
Q3b_10 = My household did not go out to eat very much.						
White Women	1.221	0.560	2.183	0.033	*	<b>0.29</b>
Asian Men	2.388	1.082	2.208	0.032	*	<b>0.29</b>
Q3b_11 = I received very little beyond the basics of what I needed.						
White Women	0.822	0.375	2.190	0.033	*	<b>0.29</b>
Asian Men	1.655	0.725	2.282	0.027	*	<b>0.30</b>
Sig. $p < 0.10$ ".", $p < 0.05$ "**", $p < 0.01$ "***", and $p < 0.001$ "****"						

and receiving very little beyond the basics of what they need ( $\beta = 0.822$ ,  $d = 0.29$ ). Asian Men showed less access, reporting less than White women's access to money for eating out ( $\beta = 2.388$ ,  $d = 0.29$ ) and receiving very little beyond the basics ( $\beta = 1.655$ ,  $d = 0.30$ ). The analysis showed that Black and male students, showed different access patterns. Black students reported a higher need to sell personal possessions to make ends meet ( $\beta = 2.226$ ,  $d = 0.29$ ), While males less ( $\beta = -0.608$ ,  $d = 0.21$ ).

Table IV shows our final regressions for socioeconomic conditions. Asian Nonbinary Students were more likely to have cluttered or dirty home environments ( $\beta = 4.630$ ,  $d = 0.33$ ), overgrown greenery surrounding their home ( $\beta = 3.185$ ,  $d = 0.30$ ), and hoarding of items by their household members ( $\beta = 5.250$ ,  $d = 0.39$ ). They also showed less easy access to grocery stores ( $\beta = -4.396$ ,  $d = 0.37$ ). Middle Eastern students showed less access to clean running water ( $\beta = -5.463$ ,  $d = 0.46$ ), visiting healthcare professionals when they needed ( $\beta = -4.926$ ,  $d = 0.34$ ), accessing grocery stores easily ( $\beta = -5.396$ ,  $d = 0.45$ ), and shopping at stores with a large variety of options ( $\beta = -5.546$ ,  $d = 0.42$ ). Other groups of students, such as White women, Black, Hispanic women, Asian men, and Black women, showed a variety of access to these socioeconomic resources. The most significant effect size among these groups of students was observed for Middle Eastern students, specifically in their access to clean running water ( $d = 0.46$ ).

Table V shows our final regressions for home emotional resources. After completing regression, we found that access to emotional resources also differed amongst intersectional race-gender groups. Hispanic students showed having more negative feelings to walking on eggshells ( $\beta = 2.188$ ,  $d = 0.32$ ), saying or doing things without thinking about others' feelings by their

household members ( $\beta = 2.078$ ,  $d = 0.27$ ), and feelings that they could never do enough to make family members happy ( $\beta = 2.478$ ,  $d = 0.33$ ). Also, Middle Eastern students showed less positive feelings of being comfortable talking with family members ( $\beta = -3.962$ ,  $d = 0.29$ ) and feelings that family members would take their concerns seriously ( $\beta = -4.076$ ,  $d = 0.29$ ). Black, White Women, and Hispanic Women showed a variety of access to these emotional resources. The most significant effect size among these groups of students was observed for Hispanic students in their negative feelings they could never do enough to make family members happy ( $d = 0.33$ ). Our findings related to emotional resource remain the most significant finding of our work, which we discuss further.

TABLE IV. REGRESSION RESULTS FOR SOCIOECONOMIC CONDITIONS

Reg.	Est.	Error	t-value	p	Sig.	d
Q3c_2 = My home was regularly cluttered or dirty.						
Asian NonBinary	4.630	1.842	2.513	0.015	*	<b>0.33</b>
Q3c_4 = The greenery surrounding my home was overgrown						
Asian NonBinary	3.185	1.401	2.273	0.027	*	<b>0.30</b>
Q3c_5 = Members of my household hoarded items.						
Asian Nonbinary	5.250	1.686	3.115	0.003	**	<b>0.39</b>
White Women	1.068	0.460	2.324	0.024	*	<b>0.29</b>
Q3c_8 = My home regularly had an issue with pests (e.g., insects, mice)						
Black	2.340	0.873	2.679	0.01	**	<b>0.35</b>
Q3c_9 = My home regularly had clean running water.						
Middle East	-5.463	1.463	-3.733	<0.001	***	<b>0.46</b>
Q3c_11 = Members of my household could visit healthcare professionals when they needed to						
Middle East	-4.926	1.869	-2.636	0.011	*	<b>0.34</b>
Q3c_12 = My household could easily access a grocery store.						
Middle East	-5.396	1.348	-4.004	<0.001	***	<b>0.45</b>
Asian NonBinary	-4.396	1.348	-3.262	0.002	**	<b>0.37</b>
Q3c_13 = My household shopped at stores with a large variety of options.						
Middle East	5.546	1.491	-3.720	<0.001	***	<b>0.42</b>
Hispanic Women	-2.046	0.770	-2.657	0.011	*	<b>0.30</b>
Asian Men	-1.796	0.770	-2.332	0.024	*	<b>0.27</b>
Black Women	-2.546	1.066	-2.388	0.021	*	<b>0.27</b>
Sig. $p < 0.10$ ".", $p < 0.05$ "**", $p < 0.01$ "***", and $p < 0.001$ "****"						

Table VI shows our final regressions for home social resources. After completing regression, we found that Hispanic students, especially Hispanic women, and Asian students, especially Asian men, were less likely to have access to emotional resources, while other students were more likely to have access to these resources. This access to resources also differed amongst intersectional race-gender groups. Asian students reported less access to social resources from their family members in discussions about college planning ( $\beta = -1.597$ ,  $d = 0.30$ ), discussions on current local/national/global events ( $\beta = -2.040$ ,  $d = 0.35$ ), discussion about personal troubles ( $\beta = -2.908$ ,

$d = 0.51$ ), help to figure out navigate their transition to college ( $\beta = -1.568, d = 0.26$ ), discussions on things of interest to the student ( $\beta = -2.000, d = 0.40$ ), and discussion about future goals ( $\beta = -1.769, d = 0.32$ ). Asian men often showed less access to these resources than Asian women. For example, they showed less access to help with homework from their family members ( $\beta = -2.413, d = 0.31$ ), discussions about school courses ( $\beta = -2.692, d = 0.37$ ), discussions about class studies ( $\beta = -2.797, d = 0.36$ ), discussion about school activities ( $\beta = -2.517, d = 0.38$ ), discussions about grades ( $\beta = -2.821, d = 0.40$ ), discussions about preparation for ACT/SAT ( $\beta = -2.167, d = 0.28$ ), help to fill out college forms ( $\beta = -2.607, d = 0.35$ ), and discussions about friends ( $\beta = -2.948, d = 0.41$ ). Also Hispanic students experienced less access to social resources from their family members in relation to discussions about preparation for ACT/SAT ( $\beta = -3.167, d = 0.40$ ), discussions about college planning ( $\beta = -3.276, d = 0.48$ ), discussion about personal troubles ( $\beta = -3.136, d = 0.43$ ), discussions about their transition to college ( $\beta = -3.711, d = 0.49$ ), and discussion about future goals ( $\beta = -2.269, d = 0.32$ ). Hispanic Women often showed less access to these resources than Hispanic men. For example, they showed less access to these resources from their family members in help with homework ( $\beta = -2.829, d = 0.31$ ), discussions about school courses ( $\beta = -2.775, d = 0.34$ ), discussion about class studies ( $\beta = -2.713, d = 0.31$ ), discussions about school activities ( $\beta = -2.101, d = 0.28$ ), discussions about grades ( $\beta = -4.333, d = 0.54$ ), help to fill out college forms ( $\beta = -5.000, d = 0.58$ ), discussions about friends ( $\beta = -3.031, d = 0.37$ ), and discussions about things that interested ( $\beta = -2.000, d = 0.27$ ). The most significant effect size among these students was observed for Hispanic women who were found to not get enough help from their household members in filling out college forms ( $d = 0.58$ ). Table VII shows our final regressions for social resources. After completing regression, we found that access to social resources also differed amongst intersectional race-gender groups. We found Asian students experienced less access to some social resources from their teachers and staff in their school help to fill out college forms ( $\beta = -2.171, d = 0.41$ ) and discussions about their future goals ( $\beta = -1.446, d = 0.32$ ). Asian men reported that they were treated differently than other students by teachers and

TABLE V. REGRESSION RESULTS FOR HOME EMOTIONAL RESOURCES

Reg.	Est.	Error	t-value	p	Sig.	d
Q3d_1 = Yelling was a regular occurrence in my household.						
Black	3.481	1.577	2.208	0.032	*	<b>0.29</b>
Q3d_3 = My household felt tense						
White Women	1.086	0.531	2.045	0.046	*	<b>0.26</b>
Hispanic Women	2.425	0.996	2.434	0.019	*	<b>0.31</b>
Q3d_4 = I commonly felt I was "walking on eggshells" in my household						
Hispanic	2.188	0.889	2.461	0.017	*	<b>0.32</b>
Q3d_5 = I felt comfortable talking to members of my household.						
Middle East	-3.962	1.835	-2.159	0.036	*	<b>0.29</b>
Q3d_6 = Members of my household took my concerns seriously						
Middle East	-4.076	1.855	-2.197	0.033	*	<b>0.29</b>

Q3d_10 = Members of my household often said and did things without thinking about the feelings of others.						
Hispanic	2.078	1.013	2.051	0.045	*	<b>0.27</b>
Q3d_13 = I feel like I could never do enough to make members of my household happy.						
Hispanic	2.478	0.997	2.485	0.016	*	<b>0.33</b>
Sig. $p < 0.10$ ".", $p < 0.05$ "**", $p < 0.01$ "***", and $p < 0.001$ "****"						

TABLE VI. REGRESSION RESULTS FOR HOME SOCIAL RESOURCES

Reg.	Est.	Error	t-value	p	Sig.	d
Q3e_2 = Members of my household helped with my homework.						
Hispanic Women	-2.829	1.198	-2.361	0.022	*	<b>0.31</b>
Asian Men	-2.413	1.049	-2.30	0.026	*	<b>0.31</b>
Q3e_3 = Members of my household discussed my school courses with me						
Hispanic Women	-2.775	1.053	-2.637	0.011	*	<b>0.34</b>
Asian Men	-2.692	0.921	-2.922	0.005	**	<b>0.37</b>
Q3e_4 = Members of my household discussed things studied in class with me.						
Hispanic Women	-2.713	1.153	-2.352	0.023	*	<b>0.31</b>
Asian Men	-2.797	1.010	-2.77	0.008	**	<b>0.36</b>
Q3e_5 = Members of my household discussed school activities with me.						
Asian Men	-2.517	0.866	-2.906	0.006	**	<b>0.38</b>
Hispanic Women	-2.101	0.990	-2.123	0.039	*	<b>0.28</b>
Q3e_6 = Members of my household discussed grades with me.						
Hispanic	0.929	1.649	0.563	0.576		0.13
Hispanic Women	-4.333	1.882	-2.302	0.026	*	<b>0.54</b>
Asian Men	-2.821	0.853	-3.308	0.002	**	<b>0.4</b>
Q3e_7 = Members of my household discussed preparation for the ACT/SAT with me						
Hispanic	-3.167	1.016	-3.116	0.003	**	<b>0.40</b>
Asian Men	-2.167	1.016	-2.132	0.038	*	<b>0.28</b>
Q3e_8 = Members of my household discussed college planning with me.						
Hispanic	-3.276	0.858	-3.819	<0.001	***	<b>0.48</b>
Asian	-1.597	0.671	-2.382	0.021	*	<b>0.3</b>
Q3e_9 = Members of my household discussed current local/national/global events with me.						
Asian	-2.040	0.796	-2.564	0.014	*	<b>0.35</b>
Q3e_10 = Members of my household had discussions with me about things that were troubling to me.						
Asian	-2.908	0.959	-3.032	0.004	**	<b>0.51</b>



Finally, Table IX shows our final regressions for school physical resources. After regression, we found that Asian students were less likely to have access to school physical resources, while other students, especially male students, were more likely to have access to school physical resources. This access to resources also differed amongst intersectional race-gender groups. Asian students were more likely to have less access to physical resources, and the strength of these effects differed. Asian students showed less access to learn to assemble and disassemble things at home ( $\beta = -2.410, d = 0.36$ ), learn to work with tools at job ( $\beta = -2.885, d = 0.43$ ), work with machines at job ( $\beta = -1.804, d = 0.28$ ), learn to fix things at job ( $\beta = -2.282, d = 0.34$ ) and learn to assemble and disassemble things at job ( $\beta = -2.141, d = 0.34$ ). Also, Asian men showed less access to work with machines and appliances at home ( $\beta = -2.487, d = 0.29$ ); Nonbinary and Middle Eastern women also reported less access to work with machines and appliances at home (Nonbinary  $\beta = -3.654, d = 0.35$ ) and (Middle Eastern women  $\beta = -4.154, d = 0.29$ ). Male students had more access in some areas, such as learning to fix things around the house ( $\beta = 1.399, d = 0.32$ ) and working with machines at a job ( $\beta = 1.793, d = 0.40$ ). The most significant effect size among these students was observed in Asian students' access to knowledge about tools ( $d = 0.43$ ).

TABLE IX. REGRESSION RESULTS FOR SCHOOL PHYSICAL RESOURCES

Reg.	Est.	Error	t-vale	p	Sig.	d
Q4a_2 = At home, I worked with machines and appliances (considered broadly, e.g., gym equipment, sewing machines, lawn mower, bikes, etc.)						
Nonbinary	-3.654	1.388	-2.633	0.012	*	<b>0.35</b>
Asian Men	-2.487	1.147	-2.169	0.036	*	<b>0.29</b>
Middle East Women	-4.154	1.939	-2.143	0.038	*	<b>0.29</b>
Q4a_3 = I learned to fix things around the house (considered broadly, e.g., plumbing, furniture, electrical wiring, etc.)						
Male	1.399	0.622	2.249	0.030	*	<b>0.32</b>
Q4a_4 = At home, I learned to assemble and disassemble things						
Asian	-2.41	0.966	-2.494	0.017	*	<b>0.36</b>
Q4a_5 = At my job, if any, I learned to work with tools						
Asian	-2.885	0.914	-3.157	0.003	**	<b>0.43</b>
Q4a_7 = At my job, if any, I worked with machines (e.g., car jack, sewing machine, lawn mower, etc.)						
Male	1.793	0.621	2.887	0.006	**	<b>0.40</b>
Asian	-1.804	0.886	-2.037	0.048	*	<b>0.28</b>
Q4a_8 = At my job, if any, I learned to fix things						
Asian	-2.282	0.964	-2.367	0.023	*	<b>0.34</b>
Q4a_9 = At my job, if any, I learned to assemble and disassemble things						
Asian	-2.141	0.902	-2.374	0.022	*	<b>0.34</b>
Sig. $p < 0.10$ "., $p < 0.05$ "**", $p < 0.01$ "***", and $p < 0.001$ "****"						

## V. DISCUSSION AND IMPLICATION

This study investigated physical, social, and emotional resource access amongst engineering students, examining how these resources are distributed across different intersectional

groups. Our findings show that there exists substantial resource inequality on the basis of gender, race/ethnicity, and specific intersectional groupings, resulting in specific groupings having more or less equitable access to various resources, including physical, social, and emotional support at home or school. Our research question focused on understanding the distribution of resources among engineering students, especially considering their gender, race/ethnicity, and other intersectional identities. We find is that there is a significant imbalance in resource allocation, especially for emotional resources, which may significantly impact students' trajectories. We briefly discuss our findings and provide potential implications for engineering education research and practice.

These findings are crucial for creating inclusive classroom environments [1]. By identifying the specific resource gaps experienced by different intersectional groups, educators can affect targeted interventions to ensure that all students have equitable access to the resources they need to succeed [6]. Such targeted interventions not only address the immediate resource gaps but also adoptive a more inclusive and supportive educational environment where all students feel valued and empowered to succeed [8]. These strategies can lead to improved academic performance, a greater sense of belonging, and increased retention rates among marginalized and minoritized students [9]. By addressing these inequities, educators, and institutions can work towards a more equitable and inclusive engineering education system, ultimately contributing to a diverse and capable engineering workforce.

### A. Physical Resources

In this study, we found that students identifying as Hispanic, particularly women, are more likely to have limited access to necessary physical educational items like computers, phones, and books at home and school, which could affect their specific educational participation in engineering. It has been mentioned in many articles that the lack of access to related physical resources will cause students to perform poorly in their academic and career fields. These effects sway towards marginalized students. One particular article, a study by Danowitz et al. [18], discusses this effect in relation to computer access, supposing that access impacts success. They propose a practical solution to the relevant digital divide by suggesting the repurposing of retired faculty laptops to aid students who do not have personal computers. This initiative can address immediate resource deficiency, could support environmental sustainability, and could be crucial in leveling the educational field, enabling equal participation in digital learning environments. Similarly, Boyle and Farreras [19] connect calculator use to performance suggesting use significantly boosts college students' mathematical performance. This funding suggesting that technological tools are crucial for enhancing learning outcomes. This finding challenges current educational policies that may restrict such tools, highlighting the need to reassess and potentially liberalize technology use in classrooms. Integrating equitable calculator use broadly could also democratize access to effective learning technologies, ensuring all students have the necessary resources to succeed academically [20]. Heptt et al. [21] highlight the significant connection between book availability at home and the development of academic language skills, underscoring that students with limited access to books

are at a developmental disadvantage, particularly in language proficiency, which is required for technical fields such as engineering. This finding suggests that enhancing early access to books, especially those which showcase STEM, could mitigate some educational inequalities. Noting the current study, we wonder whether the inequities above have unique impacts among the success of Hispanic students, especially Hispanic women. Further investigation is needed to better understand the exact mechanisms that impact student success.

### B. Social Resources

We found that students who identify as Asian, Hispanic, and Nonbinary are more likely to experience challenges in accessing social resources, and there is a significant gap in support for these students. Some articles show similar results to ours. For example, Foor et al.'s [3] examination of "individual diversity" in engineering highlights the unique challenges of students who face cultural and socio-economic barriers. Their study demonstrates the deep effects of a lack of social resources on students from different backgrounds. These barriers in engineering education. It is imperative that we bridge this gap by applying targeted involvements and programs that not only recognize but actively address the specific needs of these students, ensuring that all individuals have equal opportunities to succeed in the engineering community. This insight strengthens the importance of understanding and addressing these obstacles in engineering education. Godwin and Potvin [22] similarly investigate the impact of high school and university experiences on the formation of students' engineering identity and their participation in this field. Their findings have similarities with ours and show that social aspects in educational environments play an important role in the stability of students in engineering fields. Lee et al. [23] highlight the importance of creating inclusive learning environments and identifying essential topics to help underrepresented engineering students. Their emphasis on inclusiveness aligns with our observation of the need for engineering education to improve social support systems that can be effective for students from all backgrounds. Cross and Vick [24] indicate the necessity of rich social networks for students' academic achievement and personal well-being. By exploring the relationship between self-construal, social support, and consistency in the field of engineering, this research underscores the positive impacts of social support for students in engineering programs. Wilcox et al. [25] emphasize the importance of social support for first-year university students to stay and continue engineering programs and the necessity of access to social resources for student success. This literature highlights the need for interventions in engineering education to play an influential role in social support systems in order to consider all the essential needs of students, especially those from underrepresented groups. Our findings, in line with these studies, call for uniform efforts to create an inclusive and supportive learning environment that meets the social needs of students, particularly Asians, Hispanics, and Nonbinary groups.

### C. Emotional Resources

Finally, and maybe most imperative to this work, our study found that engineering students who identify as Hispanic or Middle Eastern experience significant challenges in accessing emotional support. Our prior work has found that having access to emotional support resources may help improve perceptions of

mental health and belonging in the engineering community [2]. Our particular study suggests that access is not uniform, leading us to wonder if access to positive thriving is uniform as well. In regards to mental health, research such as that by Gesun et al. [26] emphasize the importance of mental health in challenging academic areas like engineering, showing how our findings may work in a larger academic settings. Particularly, having social and emotional resources, students may increase students' perceptions of well-being promoting overall thriving. If certain students do not have access, their potential to thrive is also at risk. Similarly, Wright et al.'s [27] work with help-seeking behaviors explores what systemic and cultural barriers stop engineering students from searching for mental health services. Wright et al. find that these barriers impact the confidence and agency of students making them less likely to seek support. We wonder whether the barriers that Hispanic and Middle Eastern students meet atop or within engineering culture make seeking support more difficult. Finally, Jensen and Cross [28] examine stress in engineering environments. They found that females and students who are the first in their families to go to college feel greater stress and are more likely to have problems with their mental health. Jensen and Cross's [28] research supports our findings by showing how it is important for engineering programs to create an appropriate environment where students feel like they belong. Particular to our findings and those insights above, creating an inclusive requirement requires it to be culturally appropriate and meet the needs of all students. Shaping a program in this way is likely to support all students.

## VI. LIMITATIONS

One of the limitations of this study is relying on self-reported data, which comes with potential biases given students' memory of their pre-college experiences. Although these reports may reflect their personal experiences in accessing valuable resources, they may come from their subjective thoughts and may not accurately show reality. Additionally, the sample size and demographic distribution of this study, which is small, primarily from a mid-Atlantic public institution, and predominantly White and male limits its generalizability to other students and institutions. In future research, more participants from different places and different cultures can be used to obtain results from more diverse and comprehensive environments.

## VII. CONCLUSION AND FUTURE WORK

The findings from this study underscore significant disparities in the distribution of physical, social, and emotional resources among engineering students across different intersections of race/ethnicity and gender. These disparities highlight a critical need for targeted interventions to ensure equitable access to these essential resources, which profoundly impact students' academic success and well-being. Future research should aim to extend these investigations to a broader array of institutions to enhance the generalizability of the results; findings should also be connected to student outcomes. Implementing and evaluating the effectiveness of specific interventions designed to mitigate these disparities will be crucial for developing more inclusive educational environments that support the success of all engineering students.



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