Critical Analyses of Outcomes of Marginalized Undergraduate Engineering Students

Corin L. Bowen  
Dept. of Aerospace Engineering  
University of Michigan  
Ann Arbor, Michigan, USA  
clbowen@umich.edu

Aaron W. Johnson  
Dept. of Aerospace Engineering Sciences  
University of Colorado Boulder  
Boulder, Colorado, USA  
aaronwj@colorado.edu

Kenneth G. Powell  
Dept. of Aerospace Engineering  
University of Michigan  
Ann Arbor, Michigan, USA  
powell@umich.edu

Abstract—The authors present a Research Full Paper on the application of critical and liberative theories in understanding the disproportionately low student outcomes of marginalized undergraduate students studying engineering at a large, highly selective public university in the United States. In addition to looking at women students and students of color, we also examine the effects of social class on educational opportunity and performance, hypothesizing that access to financial capital is correlated to student success. In recognition of class-related structural oppression, this study introduces the framework of Freirean critical theory and other anti-oppressive frameworks as lenses through which we observe and analyze student experiences and outcomes.

We pursue a quantitative study in which we investigate engineering student outcomes based on reported gender, ethnicity, and household income level. Dependent variables include degree completion rates, time to graduation, and grade point average after the first four semesters of study. We find that students of color and working class students experience lower rates of graduation, prolonged time to degree, and lower grade point averages than students who do not fall into either of these categories. These results are heavily influenced by the intersectionality of students of color and working class students, as the two groups largely overlap both in the United States population and in the engineering student body at this institution.

The results support liberative theoretical claims that societal structures, such as patriarchy, racism, and capitalism, have filtering effects that impact the opportunities available to individuals with marginalized identities throughout their lives. As incremental interventions fail to address the roots of these problems, they cannot entirely remove the debilitating obstacles facing students from marginalized identity groups; the only true solution lies in liberation from oppressive social structures. In accordance with critical and liberative theories, engineering educators can and should contribute to liberative efforts by employing pedagogical methods that challenge structural oppression.

Index Terms—engineering education, undergraduate outcomes, diversity, equity, gender, ethnicity, socioeconomic status, matriculation, graduation rate, time to graduation, grade point average, theory of liberation, critical theory

I. INTRODUCTION

It has long been recognized that the representation rates of women and students of color in engineering leave much to be desired [1]–[4]. Interventions at the institutional level increasingly seek to mitigate the problem through incremental measures addressing recruitment and retention of these students [5], [6]. In doing so, these institutions have begun to confront internal cultural biases that render their environments hostile toward marginalized students. While it is perhaps becoming more commonplace within engineering spaces to highlight our field’s bias towards white men, the same level of awareness has not yet developed about the marginalization of engineering students who do not come from the upper reaches of the global socioeconomic strata [7]. In response, this study intends to bring students’ access to financial capital, or lack thereof, into the conversation about diversity-related representation rates and student outcomes.

This study examines several measures of student performance and achievement in engineering undergraduate education at a large, doctoral-degree granting, research-oriented, highly selective public university in the Midwestern United States. The data consist of self-reported gender, ethnicity, and annual household income levels collected upon enrollment in conjunction with university-tracked records of each student’s grade point average (GPA) and process towards degree completion. The data set includes students entering the engineering college between the Fall 2011 and Fall 2017 semesters. International students were excluded. The research goals of this study, which are pursued through statistical analyses, were as follows:

- Provide institutional context by determining if the independent variables – 1) gender, 2) ethnicity, and 3) annual household income level – and the interactions between them demonstrate a reasonable representation of the United States population and/or the population of the state in which the university is located. If neither of the above is true, determine whether the underrepresented groups identified in existing engineering education literature are also underrepresented at this highly selective research institution.
- Investigate if and how the three independent variables and their interactions are related to the dependent variables – 1) success or failure to graduate with a Bachelor’s degree in engineering, 2) time to graduation from initial enrollment, 3) and cumulative GPA at the fourth semester of study – at this institution.

After a discussion of the theoretical frameworks that guided
and informed the study and a review of related research, we present our findings on each of the topics sequentially. For each, we describe our research methods followed by a discussion of the results. We also compare our results to those of other studies, if applicable. The conclusion describes the implications of the results laid forth in this study as well as our intended future work in this area.

II. THEORETICAL FRAMEWORKS AND REVIEW OF LITERATURE

This study employs multiple critical and liberative frameworks. The theory of liberation encompasses all aspects of identity around which the structural hierarchies of society are organized [8], [9]. Through the wielding of hegemonic power, dominant groups are able to manipulate structures, conditions, and beliefs within society in order to further attain power and build their privilege. Dominant identity groups exist in relation to a potentially infinite number of attributes, and oppressive ideologies work to further the interests of the dominant group at the expense of others. The theory of liberation seeks to dismantle the many layers of systematic oppression that stifle the progress of marginalized peoples on the basis of any and all of these and other socially-constructed attributes.

Alternatively, theories exist under the metaphorical umbrella of liberative theories that focus on oppression on the basis of particular attributes of identity. The anti-oppressive branch of feminist theory aims to dismantle androcentrism and patriarchal structures within society, thus achieving the liberation of women [10], [11]. Critical race theorists oppose incremental measures attempting to correct for racial discrimination in favor of structural and educational initiatives addressing systematic racism against people of color [12], [13]. Paulo Freire’s Pedagogy of the Oppressed [14] established new foundations for the framework of critical theory, scripting the liberation of working class people from the perspective of an educator. The theory of intersectionality postulates that particular individuals will be overlooked by any theory that focuses on a single identity-based attribute; alternatively, combinations of attributes must also be considered in order to achieve liberation for all people [15], [16].

The underrepresentation of women and students of color in engineering is a commonly understood and well-researched phenomenon [1]–[3], [17]. There are also a plethora of studies documenting the educational outcomes of undergraduate engineering students on the bases of gender and ethnicity [1], [3], [17]–[28], the results of which will be compared to our findings throughout this paper. However, engineering education researchers are often wont to omit the effects of social class on educational opportunity and performance. In western countries, social class is largely defined by socioeconomic status. A few studies have examined the outcomes of engineering students on the basis of socioeconomic status [22], [29]–[31], and results will be compared where they are available. No studies could be located examining the grade point averages of engineering undergraduate students on the basis of socioeconomic status, although a few exist that study undergraduates regardless of major [32], [33].

In this paper, we will largely refrain from separating members of the so-called “middle class” from people living in poverty. This is purposeful. As is explained by critical theorists, it is in the interest of the ruling class to sustain the common belief that the oppression of the hegemonic class system is normal and unquestionable [14], [34]. As such, it is beneficial for the ultra-wealthy ruling class that members of the middle class believe the explanation that poverty is a lifestyle choice resulting from laziness and ineptitude and that they can themselves join the ranks of the ultra-rich with effort and persistence. This belief convinces the middle class not to question the sanctity of a socioeconomic system in which “the richest 20 percent of the global population receive more than 80 percent of the global income” [35, p. 250]. Contrary to the meritocratic narrative benefiting the ruling class, members of the middle class have far more in common with people in poverty than they do with the wealthy. For this reason, we refer to the socioeconomically oppressed majority, comprising roughly 80 percent of the global population, as the working class.

It is important to recognize that income is not proportionally distributed across ethnic boundaries. Figure 1 shows the median incomes of households in the United States according to 2016 census data [36]. While a significant contribution of this study to existing literature is the extension of previous studies’ bases of gender and ethnicity to include income, the inequitable distribution of income within our societies renders it prudent to examine the effects of interactions of income levels with gender and ethnicity in addition to the effects of income alone. Through these investigations, we hope to develop a better understanding of the ways in which class-based oppression manifests itself within the space of engineering education.

![Fig. 1. Median household income by ethnicity [36].](image-url)
III. INSTITUTIONAL CONTEXT

A. Methods

Gender, ethnicity, and income are treated as independent variables within this study. Gender is reported in the data as either man or woman, the only options the university provided. Ethnicity choices presented to the students included Asian (including the Indian Subcontinent and the Philippines), Black or African American (including Africa and the Caribbean), Hispanic or Latino, and White (including Middle Eastern). Students were able to select more than one ethnicity, so Two or More Ethnicities is also an ethnicity subgroup that was examined in this study. Students reporting their sole ethnicity to be American Indian, Alaska Native, Native Hawaiian, Pacific Islander, or any other Original Peoples were excluded from the study due to extremely low representation and the potential for the violation of confidentiality. However, if they also selected at least one other ethnicity, they were included in the Two or More Ethnicities subgroup. Students reported their estimated annual gross household income by selecting one of many ranges of incomes, which we then consolidated into five ranges: under $50,000, $50,000 - $99,999, $100,000 - $149,999, $150,000 - $199,999, and $200,000 or more in U.S. Dollars. Students who did not report one or more of their gender, ethnicity, and household income were omitted from the study. This left 7,621 student data points, which is 73.6% of the population of domestic students who entered the college between Fall 2011 and Fall 2017. The frequency counts of gender, ethnicity, and annual household income level are shown in Table I. The three independent variables (gender, ethnicity, and income) are tested for associations using chi-square analyses. Chi-square tests are also used to compare representation levels within subgroups to that in the United States and the state in which this university is located.

B. Results and Discussion

Women are extremely underrepresented in most engineering programs [1]–[4], and the same is true at this engineering college. In comparing the proportion of students who were women to that of the populations of the country and state (taken from the 2012 - 2016 American Community Survey 5-Year Data Profile by the U.S. Census Bureau), the discrepancy is extremely statistically significant with \( p < 0.001 \) [36]. The comparison is shown in Figure 2. Notably, results from the National Postsecondary Student Aid Study (NPSAS), a project of the National Center for Education Statistics at the United States Department of Education, show that the average representation of women in undergraduate engineering and engineering technology programs at public four-year universities in the United States is only 20.7% [37]. By that figure, this engineering college is doing slightly better than the average engineering program.

When considering the representation rates of students of various ethnicities, Black / African American and Hispanic / Latino students were very underrepresented (see Figure 3). When comparing the ethnicity distribution of the engineering college starters to either state or national distributions, the results are very statistically significant, with \( p < 0.001 \) in both cases. The underrepresentation of students of color has been very well documented in existing literature [1], [18]–[23], [26]–[28].

While women were underrepresented in all ethnicities at this institution, they were least underrepresented amongst Black / African American students, at 33.0%, and students who reported two or more ethnicities, at 31.3%. White students, in contrast, were only 26.3% women. While the correlation between gender and ethnicity had a \( p \)-level of \( p = 0.065 \), which is slightly above what is typically considered to be statistically significant [38], this finding is consistent with results reported in literature [1], [17].

Working class students were extremely underrepresented in our data. The median annual household income in the US was $67,871 in 2016 for families of two or more related members [36], but two-thirds of the students in our study were from households earning at least $100,000 per year. As shown in Figure 4, students from households making less than $50,000 per year, while comprising over a third of the national and state populations, made up a mere 13.1% of the engineering college’s starters. (Note that, in Figure 4, the annual household income levels of $150,000 - $199,999 and $200,000 and above have been combined due to a lack of separation in the data from the NPSAS.) Compared to distributions at either the state or national level, this distribution was very statistically significant with \( p < 0.001 \). This is consistent with previous findings that socioeconomically disadvantaged students are

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**TABLE I**

FREQUENCY COUNTS OF GENDER, ETHNICITY, AND ANNUAL HOUSEHOLD INCOME LEVEL.

<table>
<thead>
<tr>
<th>Annual Household Income Level</th>
<th>Men</th>
<th>Women</th>
<th>Men</th>
<th>Women</th>
<th>Men</th>
<th>Women</th>
<th>Men</th>
<th>Women</th>
<th>Men</th>
<th>Women</th>
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<tr>
<td>$&lt;50,000</td>
<td>130</td>
<td>69</td>
<td>46</td>
<td>23</td>
<td>96</td>
<td>27</td>
<td>34</td>
<td>15</td>
<td>782</td>
<td>123</td>
</tr>
<tr>
<td>$50,000 - $99,999</td>
<td>226</td>
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<td>21</td>
<td>98</td>
<td>35</td>
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<td>301</td>
<td>106</td>
<td>27</td>
<td>11</td>
<td>75</td>
<td>29</td>
<td>57</td>
<td>20</td>
<td>840</td>
<td>308</td>
</tr>
<tr>
<td>$150,000 - $199,999</td>
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<td>72</td>
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<td>6</td>
<td>64</td>
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<td>33</td>
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<td>516</td>
<td>194</td>
</tr>
<tr>
<td>$200,000 &amp; $299,999</td>
<td>286</td>
<td>94</td>
<td>20</td>
<td>9</td>
<td>83</td>
<td>29</td>
<td>40</td>
<td>27</td>
<td>1,065</td>
<td>463</td>
</tr>
</tbody>
</table>

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Fig. 2. Percentage of women in populations [36], [37].
Our findings show that, while Black / African American students, Hispanic / Latino students, and working class students were all largely underrepresented groups, they also largely overlapped, as these two ethnicity subgroups contain significantly more working class students than other ethnic groups (see Figure 5). Conversely, the overrepresented groups of White students and ruling class students also share significant overlap. This is consistent with findings from the U.S. Census (shown in Figure 1) [36]. Thus, we begin to see the significance of the interaction between ethnicity and income level in our data, which are correlated with a statistical significance of \( p < 0.001 \).

**IV. Graduation Rates**

**A. Methods**

Success or failure to earn a Bachelor’s degree in engineering is a dependent variable in our analyses. We only considered students who entered the college between Fall 2011 and Fall 2013 in order to give them ample time to graduate; since the data is as of November 2019, the Fall 2013 cohort had had nearly six years to graduate, and the Fall 2011 cohort had had nearly eight. 2,930 of the students had either graduated or left the university and were considered for this analysis. Twenty-four students were still enrolled in the engineering college at the time the data was taken and are omitted from the analysis, but they account for less than one percent of the population. The frequency counts of gender, ethnicity, and annual household income are shown in Table II.

Because the nature of the variable is dichotomous, we perform a logistic regression by converting each subgroup into an indicator variable. Thus, the regression fits the coefficients of nine indicator variables (one gender, four ethnicities, and four income ranges) to find the deviation of their likelihood of graduation from that of the intersectional base subgroup of White men coming from households with incomes at or above $200,000 per year. This subgroup was selected on the basis of liberative frameworks’ theory of privilege for these particular subgroups.

**B. Results and Discussion**

The results of the logistic regression are shown in Figure 6. Gender was not found to be statistically significant in the model of graduation rate, consistent with many findings in the literature [1], [3], [18]–[20], [27] but contrary to others [24], [25]. Ethnicity and income were both statistically significant, however.

The model shows that Black / African American and Hispanic / Latino students, who, as we showed in Figure 5, were on average less wealthy than other ethnicities, were also less likely to graduate. Our data of graduation rates subjugated by ethnic group are shown in Figure 7. These findings are consistent with those of other studies of persistence and graduation rates [20], [23], [26], [28]. As can be seen in Figure 3, White students were the only ethnic subgroup that increased in representation between matriculation and graduation in our
Fig. 4. Percentage of populations by annual household income [36], [37].

TABLE II

<table>
<thead>
<tr>
<th>Annual Household Income</th>
<th>Asian Men</th>
<th>Asian Women</th>
<th>B / AA Men</th>
<th>B / AA Women</th>
<th>H / L Men</th>
<th>H / L Women</th>
<th>Two or More Men</th>
<th>Two or More Women</th>
<th>White Men</th>
<th>White Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; $50,000</td>
<td>34</td>
<td>17</td>
<td>17</td>
<td>3</td>
<td>34</td>
<td>17</td>
<td>16</td>
<td>7</td>
<td>4</td>
<td>143</td>
</tr>
<tr>
<td>$50,000 - $99,999</td>
<td>34</td>
<td>17</td>
<td>17</td>
<td>3</td>
<td>34</td>
<td>17</td>
<td>16</td>
<td>7</td>
<td>4</td>
<td>143</td>
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<tr>
<td>$100,000 - $149,999</td>
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<td>17</td>
<td>17</td>
<td>3</td>
<td>34</td>
<td>17</td>
<td>16</td>
<td>7</td>
<td>4</td>
<td>143</td>
</tr>
<tr>
<td>$150,000 - $199,999</td>
<td>34</td>
<td>17</td>
<td>17</td>
<td>3</td>
<td>34</td>
<td>17</td>
<td>16</td>
<td>7</td>
<td>4</td>
<td>143</td>
</tr>
<tr>
<td>&gt; $200,000</td>
<td>34</td>
<td>17</td>
<td>17</td>
<td>3</td>
<td>34</td>
<td>17</td>
<td>16</td>
<td>7</td>
<td>4</td>
<td>143</td>
</tr>
</tbody>
</table>

data. The coefficients of the model, given in terms of log odds, can be used to calculate the odds of graduation for each indicator variable in comparison to the base. For example, the odds of graduation are 1.8 times better for the base student than for a Black / African American student with $p = 0.041$. Likewise, the odds of graduation for the base student are 1.75 times better than for a Hispanic / Latino student, with $p = 0.004$.

Income, however, was even more significant than ethnicity in this model. The single largest predictor of failure to graduate was an annual household income of less than $50,000, as the base student’s odds of graduating were 2.0 times better than those of the low income student with $p < 0.001$. (As we saw in Figure 3, only 10.9% of graduates were from households with annual incomes of less than $50,000.) The base student’s odds were also 1.5 times those of students from households of incomes between $50,000 and $99,999 with $p = 0.005$. Our data showed that increasing annual household income increased likelihood of graduation up to the $150,000 - $199,999 income level, after which point it stabilized. These results are consistent with previous findings that students from socioeconomically disadvantaged backgrounds exhibit lower graduation rates compared to their wealthier counterparts [22], [29]–[31]. The effect size of annual household income within our model, which is at or above that of ethnicity, demonstrate that ethnicity data alone are not sufficient to predict the likelihood of graduation for most students. Our data of graduation rates for various income level groups are also shown in Figure 7.

Fig. 5. Distribution of annual household income by ethnicity.
Analysis of Variance (ANOVA) tests are performed in order to determine the dependence of time to graduation on the independent variables. In addition to considering gender, ethnicity, and income individually, we also consider interactions between them in accordance with intersectionality theory.

B. Results and Discussion

A three-way Analysis of Variance showed no statistical significance on any independent variable within the model, including interactions, except ethnicity, which was significant with $p < 0.001$. Thus, we performed a one-way Analysis of Variance on ethnicity alone, yielding the model shown in Figure 8. This model shows that ethnicity accounts for 2.2% of the variation in students’ time to graduation. From the plot of the adjusted predictions, we see that Black / African American students took a semester longer to graduate than other students on average, and that their results are the most sporadic (measured by standard error). White and Asian students, on the other hand, had the shortest average time to graduation, equal to about the standard eight semesters of study, as well as the most consistent results. These findings are consistent with those of Fenske, Porter, and Dubrock, who also found similar dependence on ethnicity in time to graduation for engineering undergraduates [22].

VI. GRADE POINT AVERAGE

A. Methods

Lastly, we consider the dependent variable of GPA as a quantitative measure of student performance. Students’ cumulative GPAs are taken from their fourth semester of study in order to strike a balance between early semesters, in which students take a limited number of engineering classes due to general education requirements, and later semesters, by which time many struggling students have withdrawn from the engineering college. By the fourth semester of study, the students in the engineering college have taken at least two semesters of major-specific coursework. Fourth-semester GPA is a continuous variable ranging in value from 0.842 to 4.198 (an A+ grade within the school of business at this institution was previously worth 4.3 towards a student’s GPA, so a few students who took business classes were able to achieve cumulative GPAs higher than 4.0).

ANOVA tests are performed to model the dependence of gender, ethnicity, income, and their interactions on fourth-semester GPA. 6,998 of the original 7,621 students included in the representation analyses received a cumulative GPA in their

<table>
<thead>
<tr>
<th>Annual Household Income</th>
<th>Asian</th>
<th>B / AA</th>
<th>H / L</th>
<th>Two or More</th>
<th>White</th>
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<tbody>
<tr>
<td>$&lt; 50,000</td>
<td>30</td>
<td>13</td>
<td>8</td>
<td>12</td>
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<td>$100,000 - $149,999</td>
<td>92</td>
<td>43</td>
<td>8</td>
<td>22</td>
<td>4</td>
</tr>
<tr>
<td>$150,000 - $199,999</td>
<td>56</td>
<td>26</td>
<td>3</td>
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<td>2</td>
</tr>
<tr>
<td>$&gt; 200,000</td>
<td>64</td>
<td>22</td>
<td>7</td>
<td>21</td>
<td>7</td>
</tr>
</tbody>
</table>

V. TIME TO GRADUATION

A. Methods

Time to graduation, the next dependent variable, is analyzed for the 2,277 cohort (non-transfer) students within the graduation rate analysis who successfully completed an engineering Bachelor’s degree. The frequency counts of gender, ethnicity, and income level for these students are shown in Table III. Time to graduation is a continuous variable that measures the time in years between the student’s first enrollment in the engineering college and the student’s graduation (including any semesters that they were not enrolled).

![Fig. 6. Logistic regression of graduation rate (base: White man with an annual household income above $200,000).](image)

![Fig. 7. Graduation rate by ethnicity and annual income level.](image)
fourth semester after enrollment, meaning that they had not left the engineering college by that point or taken that semester off. Frequency counts of gender, ethnicity, and income for these students are shown in Table IV.

B. Results and Discussion

The results of a three-way Analysis of Variance, while significant with \( p < 0.001 \), do not show any significance of gender or of any interactions including gender. This is somewhat consistent with Lord et al.’s finding that women achieve equal or slightly higher GPAs than men but contrary to their result of Black / African American women achieving significantly higher GPAs than Black / African American men [1]. Due to the results of our three-way model, we instead perform a two-way Analysis of Variance on ethnicity, income, and their interaction. The resulting model, which is shown in Figure 9, is dependent on all three components to a statistically significant degree and accounts for 4.8% of the variation in students’ fourth-semester GPAs.

![Fig. 8. ANOVA model of time to graduation by ethnicity.](image)

**Figure 8.** ANOVA model of time to graduation by ethnicity.

![Fig. 9. ANOVA model of fourth-semester GPA by ethnicity, income, and their interactions.](image)

**Figure 9.** ANOVA model of fourth-semester GPA by ethnicity, income, and their interactions.

### TABLE IV

<table>
<thead>
<tr>
<th>Annual Household Income</th>
<th>Asian Men</th>
<th>Asian Women</th>
<th>H / AA Men</th>
<th>H / AA Women</th>
<th>H / L Men</th>
<th>H / L Women</th>
<th>Two or More Men</th>
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<th>White Men</th>
<th>White Women</th>
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<td>89</td>
<td>41</td>
<td>18</td>
<td>68</td>
<td>26</td>
<td>40</td>
<td>28</td>
<td>722</td>
<td>198</td>
</tr>
<tr>
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<td>100</td>
<td>25</td>
<td>11</td>
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<td>25</td>
<td>52</td>
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<td>22</td>
<td>999</td>
<td>400</td>
</tr>
</tbody>
</table>
Ethnicity, which is significant with $p < 0.001$, had the largest effect on student GPA. Hispanic / Latino students were predicted to achieve GPAs that were 0.15 - 0.20 lower and Black / African American students were predicted to achieve GPAs that were 0.30 - 0.35 lower than those of students of the remaining ethnic subgroups. These findings are consistent with those of Lord, et al. [1]. Distressingly, the 95% confidence intervals for these three populations (Hispanic / Latino, Black / African American, and other ethnicities) do not even overlap in our model.

Income is also statistically significant in the model with $p < 0.001$. Our data had shown that lower income students had lower GPAs and performed more sporadically and higher income students had higher GPAs and performed more consistently (with consistency of performance measured by standard deviation). The behavior of the means and standard deviations in these results was completely monotonic. The 95% confidence intervals for the lowest income students do not overlap with those coming from households making more than $50,000 per year. The model predictions for the effect of income on GPA along with 95% confidence intervals are included in Figure 9.

Additionally, the ANOVA model found the interaction between ethnicity and income to be statistically significant with $p = 0.013$. In the interaction plot included in Figure 9, we observe that, for low income students, Hispanic / Latino and Black / African American students have significantly lower GPAs than students in the remaining ethnic subgroups. However, as income increases, Hispanic / Latino students are able to “catch up” to the remaining ethnic subgroups, but Black / African American students are not. This is an important finding, both in terms of intersectionality and the lack thereof, for Hispanic / Latino and Black / African American students, respectively.

VII. Conclusions

This study looked at the program-related outcomes of engineering undergraduate students on the bases of gender, ethnicity, and annual household income at a large, research-oriented, highly selective public university. Consistent with the claims of liberative and critical theories, we found that students of marginalized identity groups, including women, people of color, and members of the working class, experience hindrances in their opportunities to access and succeed in engineering education. However, the ways in which the attributes of gender, ethnicity, and income interact with one another throughout the educational experience are varied and nuanced. The main findings of this study are summarized as follows:

- Women, students of color, and working class students are grossly underrepresented at this institution.
- Working class students have greater representation amongst students of color.
- Students who are either people of color or working class are less likely to graduate than those who are neither.
- Income is even more significant than ethnicity in affecting likelihood of graduation.
- Black / African American students take a semester longer to graduate than other students.
- Students of color have significantly lower GPAs than other students.
- Aggregated by ethnicity, students have GPAs that are approximately .06 higher for every $50,000 of annual household income.
- The GPAs of Hispanic / Latino students improve to the level of students who are not people of color for those of the ruling class. However, high levels of income do not improve the GPAs of Black / African American students.

These results demonstrate that, while we may be more aware of gender and ethnic minorities within our midst as engineering educators due to these groups’ inescapable noticeability, working class students comprise an often-invisible minority group that is also fundamentally disadvantaged and in need of support. This is not to detract from the very real systematic marginalization experienced by students on the bases of gender and ethnicity that are documented in this study and others; rather, we hope to describe why interventions are necessary on behalf of working class students in addition to women and ethnic minorities. Many students of marginalized ethnicities will themselves reap benefits from income-based educational support structures, since financial capital is disproportionately distributed across ethnic boundaries within our societies.

It is imperative that the results of this study be interpreted not as a failure of those of marginalized identities to thrive, but as a failure of those of privileged and powerful identities to enact conditions that allow marginalized populations to be successful. In future studies, we intend to better connect these quantitative results to the processes described in liberative and critical theories through qualitative study of marginalized engineering student experiences. As processes of oppression become better understood by engineering educators, further development and use of critical and liberative pedagogies [5], [39]–[42] will be necessary in order to bring about structural change. Through a combination of awareness, advocacy, and solidarity, privileged and marginalized peoples can and must work together to overcome oppression in every societal space – including engineering academia.

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