

First-time Academically Suspended Engineering (FASE) Undergraduate Outcomes: Two Engineering Undergraduate Programs Examining Trends of Over and Underrepresentation at the Intersection of Ethnicity and Sex

Mrs. Lisa Lampe, University of Virginia

Lisa Lampe is the Director of Undergraduate Education in the University of Virginia's School of Engineering and Applied Science, joining UVA in January 2014. Prior to that, she served in many roles that bridge student affairs and academic affairs including Student Services Specialist and Residence Dean at Stanford University, as well as Hall Director and Interim Area Coordinator for residential academic programs at the University of Colorado-Boulder. She is currently a Ph.D. candidate in Higher Education at the School of Education and Human Development at the University of Virginia.

Ms. Megan Harris, University of Colorado Boulder

Megan has worked in higher education for 15 years, focusing on students success, retention, and graduation initiatives. Megan has focused on STEM students for 8 years, creating and implementing large student success programs at highly ranked engineering schools. Currently at the University of Colorado at Boulder College of Engineering, Megan's team focuses on innovation, culture change, and academic success for undergraduate students.

Kayla Brooks, University of Colorado Boulder

Kayla Brooks is the Data Analyst for the College of Engineering at the University of Colorado Boulder, joining in April 2020. Before that, she worked in data-related roles, including Program Evaluator at Vantage Evaluation, Monitoring and Evaluation Coordinator at One Earth Future Foundation, and Professional Research Assistant at the University of Colorado-Anschutz Medical Campus.

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Abstract

This work in progress described trends of over and underrepresentation of first-time academically suspended engineers' (FASE) outcomes at the intersection of ethnicity and sex. Outcomes included return to engineering from suspension and graduation rates. The rationale for this study was based on a gap in graduation rates based on ethnicity and to kick start a future examination of how suspension policies and institutional environments play a role in inequitable outcomes. Our sample included undergraduates matriculated at two selective engineering programs, both Predominantly White Institutions (PWI). Students were admitted between Fall 2009 to Fall 2018 with term data from Fall 2009 to Spring 2019. There were 1,199 FASE students among the 20,043 undergraduates in our sample. The two institutions suspended six percent of students.

We reported FASE outcomes in aggregate, namely institutions attracted 21 percent of FASE returners to engineering. Of FASE returners with enough semesters in the dataset, institutions graduated 73 percent. Consistent with literature, males and Black students were overrepresented within FASE students. By disaggregating by ethnicity and sex, we provided more nuanced trends. For example, while males were overrepresented among FASE students, White males were not. Where females were underrepresented among FASE students, Latino and Black females were not. Asian males were the only group overrepresented among FASE students and underrepresented among FASE returners. To build off of these descriptive statistics of FASE undergraduates, we recommended future research and interventions based on Critical Race Theory (CRT) to lead to greater equity in engineering graduation rates.

Introduction

The National Student Clearinghouse Research Center recently reported the smallest increase of 0.3 percentage points in six-year college completion rates [1]. Of those who started in a 4-year public US institution, 67.4% completed that degree in six years [1]. The percentage point gap between Black and White students in four-year public institutions narrowed slightly from 25 to 23 percentage points from 2019 to 2020 [1], [2]. Among students who initially entered science, technology, engineering and mathematics (STEM) fields, research found that 48 percent of students had left within the six-year period of study [3]. To remain competitive in the global economy, the US must meet the increasing demand of STEM jobs [4]. The majority of STEM jobs are filled by white males and if minoritized populations were represented similarly with regards to initial interest, the shortage of STEM talent supply would be satiated [5].

Within engineering, this gap furthers economic inequality and hinders our ability to meet industry demand for diverse engineering talent [6]. Student retention researchers suggested we examine teaching methods, financial supports, and educational policy to mitigate student departure and promote academic success [7]. Publications have been plentiful on improving pedagogy and addressing student financial constraints with little examining educational policy outcomes [8]. We found no literature within the last three years examining academic standing outcomes within conference proceedings of the American Society for Engineering Education and

Journal of Engineering Education. Therefore, we chose to report trends in outcomes of FASE students, specifically return and graduation rates. The question remains, who do institutions attract back from academic suspension and graduate?

Institutions academically suspend students to ensure students persist toward graduation only if eligible. Academic suspension, in tandem with probation, was intended to increase student awareness of performance and connect them with resources to meet graduation requirements of 2.0 cumulative grade point average (GPA). Because institutions graduated less minoritized engineers, we utilized Critical Race Theory (CRT) methodology to research academic suspension outcomes [9].

CRT examines the “unequal and unjust distribution of power and resources along political, economic, racial and gendered lines” [10, p. 5], [11]. We followed the CRT researcher recommendations as we formed research questions, analyzed student record data, and reported academic suspension rates. We formed our questions to frame how institutional factors might lead to inequity, conducted analysis of outcomes at the intersection of ethnicity and sex, and focused discussion on future research needed to examine institutional factors [9]. There are two reports that we built off of and further justify our utilization of CRT – one specific to engineering and the other more generic to undergraduates across Oklahoma over time.

First, academic policies in engineering programs were complex in multiple ways - GPA cutoffs, length of suspension, number of suspensions allowed, and warnings might occur or not prior to suspension [8], [12]. To delineate these differences, researchers detailed academic policies ranging from 1988 to 2018, specifically academic probation, suspension, and course grade forgiveness policies within engineering programs at nine institutions. The GPA cutoff differed by institution and over time, with most institutions increasing to the 2.0 standard by 2005 with the highest at 2.25 by 2018. Academic suspension was defined as a “requirement to separate from the university for a period of time, usually a semester or academic year. Students may be suspended more than once” [7, p. 9].

Second, based on a statewide report more general than engineering, we know institutions placed students on academic suspension at a higher rate by ethnicity as well as sex, independent of one another. The study described Oklahoma institutions in 1990s, not specific to engineering, and reported percentages of academically suspended students [13]. This report by the Oklahoma Regents for Higher Education disaggregated percentages of students academically suspended by ethnicity and sex separately. For example, the average suspension rate at comprehensive 4-year universities within the ten-year dataset for Black students was 10.9 percent as compared to 4.1 percent of White students [13]. The Regents acknowledged across the board that the “percentage of undergraduate students suspended continues to be the highest for Black students” [11, p. 6]. In one academic year, the suspension rate for Black students was as high as 17.6 percent [13]. This report also disaggregated by sex. For example, the average suspension rate at comprehensive 4-year universities within the ten-year dataset for male students was 5.9 percent as compared to 3.4 percent of females [13]. The Regents acknowledged student resource expansion and correcting institutional deficits improved student retention outcomes. However, when reporting the increased retention rates, the Regents failed to report the outcome by ethnicity and sex.

Institutional Background

The institutions – University of Colorado at Boulder (A) and University of Virginia (B) – included in this study were public doctoral granting, Research I comprehensive universities with admission offer rates around 30-40 percent in the engineering undergraduate school. These PWI

institutions were located in A) the Midwest and B) the Mid-Atlantic. Academic probation and suspension policies differed by institution. Institution A shifted its probation and suspension policy from a 2.00 cut off to a 2.25 in 2011. Institution A also simplified its probation policy and limited the ways a student could be suspended in 2018. Institution B moved its first-year probation cut off from 1.8 to 2.0 in 2014 with no changes in suspension policy. Both engineering programs allowed for return from academic suspension. Second, both engineering programs hired student success staff in A) 2016 and B) 2014. These shifts will be factors in future publications as both institutions acknowledge their need to improve outcomes for their engineering students at the intersection of ethnicity and sex. For now, we asked the following questions for trends:

RQ1: To what extent did each institution produce over and underrepresentation between enrolled student percent and first-time suspended engineering (FASE) undergraduate percent at the intersection of ethnicity and sex?

RQ2: To what extent did each institution produce over and underrepresentation between percent FASE students and FASE returner percent at the intersection of ethnicity and sex?

RQ3: What were graduation outcomes of FASE undergraduates who return from suspension for those who returned to engineering and had a 6-year window within the dataset?

Methods

This paper conducted a descriptive analysis of FASE undergraduates using student record, term-level data for students enrolled in one Mid-Atlantic or Midwestern engineering program admitted from Fall 2009 to Fall 2018. Initially the dataset included all undergraduates and we narrowed the sample to those ever in engineering between the Fall 2009 to Spring 2019 terms. With 20,043 ever engineering undergraduates in this sample, there were 1,199 FASE students. Similar to the Oklahoma report [13], we utilized the Integrated Postsecondary Data System (IPEDS) categories – Asian, Black or African American, Hispanic, Native Hawaiian or Pacific Islander, Nonresident Alien, Race/ethnicity Unknown, and White – and binary sex categories – female and male. Due to small counts, we created an “Other” category to aggregate Native Hawaiian or Pacific Islander, Nonresident Alien, and Race/ethnicity Unknown. By institution, we reported the counts and percentages of students ever enrolled in engineering, counts and percentages of those students ever academically suspended, followed by counts and percentages of students who returned from suspension.

For example, Asian females composed 3.7% of the students enrolled in engineering at the two institutions from Fall 2009 to Spring 2019. Asian females composed 2.0% of suspended students. Next, we calculated the difference between enrollment and suspension to calculate difference in suspension percentage. Asian females were underrepresented on suspension by 1.73% (i.e. $2.0\% - 3.7\% = -1.73\%$). Similarly, Asian females were underrepresented among FASE returners (i.e. $1.95\% - 2.0\% = -0.05\%$).

For graduation rates across both institutions, we included FASE students admitted Fall 2009 to 2014 to allow time-and-a-half semesters to graduate and provided counts and percentages graduated. Our student record data collection and analysis were IRB approved (#2433).

Preliminary Aggregated Results

The two engineering programs suspended six percent of students (A: 8%, B: 2%). Of 1,199 FASE students, 256 returned (21%) to engineering (A: 16%, B: 54%). Of the 256 FASE returners in the dataset, 154 had enough semesters in the dataset to capture whether they had graduated in a 6-year window. For example, students in engineering admitted Fall 2015 would be limited by only having four years of data in our dataset, lacking the required number of semesters to be eligible to graduate. Of those 154 students with enough terms in the dataset, the institutions graduated 113 FASE returners (73.4%). See Table 1.

Across the two engineering programs and for FASE students who had a window of 6-years (n=154), about three-fourths (n=113) graduated from their institutions. While we were not able to report the graduation rates within engineering by ethnicity and sex due to at least one group not having any graduate in engineering, we will note Asian males were most overrepresented among engineering graduates (9 percent of FASE returners and 12 percent of engineering graduates).

Lastly, in aggregate by ethnicity and sex and not at the intersection, the Oklahoma report held true in terms of overrepresentation of Black and male students within engineering, overrepresented by 9.0% and 4.05% respectively. See Table 2.

Preliminarily Intersectional Results

Our intersectional results delineated more nuance to these findings. While females were underrepresented among FASE students, Latino and Black females were overrepresented (1.47% and 0.87% respectfully; see Table 3). While males were overrepresented among FASE students, White males were underrepresented (-5.36%). Asian males were the only group overrepresented among FASE students and underrepresented among FASE returners, 1.59% and -0.11% respectively. While Black students were overrepresented among FASE students, Black males were overrepresented by 3.17% in comparison to Black females by 0.87%.

Limitations and Improvements

Return to engineering counts were complicated by the fact that Institution B required students to return to engineering before transferring to another school within the institution,

Institution	Enrollment	Suspended	Returned	Returned & Eligible	Graduated	Graduated in Engineering
All	20043	1119 (6%)	256 (21%)	154	113 (73.4%)	90 (58%)
A	12563	1039 (8%)	169 (16%)			
B	7480	160 (2%)	87 (54%)			

Table 1. Total Enrollment, Suspended, FASE Return to Engineering Counts (Percentages) by Institution from Fall 2009 to Spring 2019.

	Enrollment	Suspended	Susp Diff
Male	14328 (71.49%)	965 (80.5%)	9.00%
Black	459 (2.29%)	76 (6.34%)	4.05%

Table 2. Counts (Percentages) of Enrollment and Suspension Data for males and Black students admitted Fall 2009 to 2018

potentially leading to a higher return rate for Institution B. For graduation rates, we captured a ten-year window of graduation for those admitted Fall 2009, which gave them a longer period to graduate as compared to the students admitted in Fall 2014. We also did not include transfer students admitted after Fall 2014 which we could have, based on their time-and-a-half (3-year) window. Lastly, we acknowledge the limitations of IPEDS categorical data for ethnicity and a binary variable for sex. To be able to compare to past research and to utilize the easiest counts of unique students, we fell short of diversity and inclusion efforts to be more inclusive of multiple ethnicities and a gender spectrum instead of a binary sex variable [14], [15].

Discussion

This works in progress paper examined trends of return and graduation rates of first-time academically suspended engineering (FASE) students. We utilized a critical lens in order to delineate outcomes for future work to examine any link to inequity through the distribution of power and resources with regards to ethnicity and sex. Policy makers and academic administrators lacked research examining academic suspension outcomes in general. Without our description of trends, institutions may continue to implement change to their academic policies and resources without accountability to critically think through who they are attracting back and graduating among FASE undergraduates. Without any published data, institutions did not have a sense of what improvement might look like compared to other institutions.

Based on Critical Race Theory (CRT), we followed recommendations to examine FASE outcomes [5], [9]–[11], [16]. First, we recommended a paradigm shift from students as the deficit to institutions and policies as the deficit. Second, in order to examine FASE trends at the intersection of ethnicity and sex, we must examine FASE outcomes across institutions and over time in order to have an adequate dataset. Third, future research will require interdisciplinary researchers with different methodologies – quantitative and qualitative – with motivational and cultural lenses. Fourth, the findings of these outcomes and subsequent interventions should impact policies at the institutional, state and federal levels.

First and foremost, we encourage institutions to examine their data, over time and to adjust practices to not only identify students who are struggling but to take ownership of the environments and policies that potentially lead to overrepresentation on academic suspension and underrepresentation of FASE returners. In other words, when policy makers make changes to policy such as GPA cut offs, provide staffing or interventions, they should continue to monitor

Ethnicity - Sex	Susp Diff	Return Diff
Other - Male	5.36%	1.29%
Hispanic - Male	4.22%	0.90%
Black - Male	3.17%	1.58%
Asian - Male	1.59%	-0.11%
Hispanic - Female	1.47%	0.07%
Black - Female	0.87%	2.24%
Asian - Female	-1.73%	-0.05%
Other - Female	-2.16%	0.01%
White - Male	-5.36%	-6.80%
White - Female	-7.46%	0.87%

Table 3. Heat Map of Percent Difference between Suspension and Enrollment, Between Suspension and Return at the Intersection of Sex and Ethnicity from Fall 2009 to Spring 2019.

any trends in outcomes and not merely be satisfied with aggregate outcomes. In the case of this study, these two institutions plan to continue to track outcomes for years to come after their increase in GPA cut off as well as implementation of student success staff. Cathy O'Neil, in her book *Weapons of Math Destruction*, explained "we've seen time and again that mathematical models can sift through data to locate people who are likely to face great challenges, whether from crime, poverty, or education. It's up to society whether to use that intelligence to reject and punish them—or to reach out to them with the resources they need" [15, p. 2]. In order to intervene and reduce inequitable outcomes, policy makers must first examine who they place on academic suspension, who they attract to return and graduate and strategically think about the resources they allocation for student success. To date, no study has reported how many students return from academic suspension, so this is the first.

An intervention that reduces academic suspension or increases return and graduation rates in aggregate is simply not enough. Institutions should interrogate if interventions or changes to policy lead to equitable outcomes. Researchers suggest institution employ equity-minded or race-conscious change and accountability [18]. Future research could examine how much of the percentage point gap is explained by institutions not attracting FASE returners from each group. There is a 23 percent point gap between Black and White students [1]. How much of that gap is explained by FASE students not returning? How much of that gap is explained by returners not completing a degree?

Descriptive analysis of FASE students was the first step in raising awareness of outcome trends. We would like to partner with institutions who would like to track their policy and intervention changes to join in causal or experimental research designs across institutions to examine graduation equity. In this works in progress study, we found greatest overrepresentation among positively and negatively stereotyped groups within engineering (Asian and Black males), so our inclination would be to recommend those with educational psychology backgrounds join in the research with a motivational lens, particularly interrogating outcomes based on environmental factors such as campus culture, mindset and stereotype threat [19]–[21].

Second, we want those conducting future research to be informed regarding the contextual knowledge that must accompany datasets such as the Multiple-Institution Database for Investigating Engineering Longitudinal Development (MIDFIELD). While large datasets will enable researchers to study FASE students at the intersection of ethnicity and sex, we must do so in conjunction with environmental factors and academic policies. We recommend interrogating how the culture, student and faculty composition has on FASE return and graduation as well as the academic policies.

Past literature has not addressed how to count FASE returners. Based on the difference in return rates, we suspect that FASE return rates could be impacted by reenrollment policies outside of academic suspension. For example, Institution B required its students to return to the school of enrollment, increasing the count of students who returned to engineering. In contrast, Institution A allowed students to reenroll into schools outside of engineering, likely decreasing the count of students who returned to engineering. Future research will need to consider the global pandemic and altered grading options, which serve as the basis for academic suspension. For example, grading options were drastically altered during the pandemic at both of these institutions.

Third, to critically examine policy differences and inequitable outcomes, researchers will be needed across disciplinary domains. For example, shifts in policy will need both a quasi-

causal analytical skill set coupled with qualitative research. Research lenses might include quantitative analysis such as regression discontinuity or structural equation modeling by group, and qualitative analysis to examine stereotype threat or mindsets of administrators. For an institution with an overrepresentation in Asian or Black FASE students, we would suggest learning more about the model minority and inferior minority myth and interventions to reduce stereotype threat in return rates [16]. The key recommendation of this article on stereotype implores administrators to acknowledge the extra burden stereotypes play in learning with the goal to 1) minimize racial stereotypes and prejudices and 2) support messages and a culture where stereotyped individuals believe in their unique strengths and value as members of an academic engineering community.

Fourth, as researchers, we must disseminate findings of inequity on multiple levels – institutional, state, federal. As practitioners, we must be committed to not only trying what intuitively helps reduce inequity but also demonstrate how we have reduced inequities and be accountable in our initiatives. The recent policy and resource changes we described will require at least a ten-year window across multiple institutions. We remain committed to share findings.

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