

Contextual analysis of engineering student academic success at a Hispanic Serving Institution (HSI)

Farshid Marbouti
College of Engineering
San Jose State University
San Jose, CA, USA
farshid.marbouti@sjsu.edu

Julia Thompson
College of Engineering
San Jose State University
San Jose, CA, USA
julia.thompson@sjsu.edu

Jale Ulas
College of Engineering
San Jose State University
San Jose, CA, USA
jale.ulasmarbouti@sjsu.edu

Abstract—In this Research to Practice Full Paper, we analyzed 60,427 student-semester entries from 12,053 engineering students, enrolled at a Hispanic Serving Institution (HSI) over 8 years, to investigate contextually relevant factors of student academic success. We examined the relation of student semester Grade Point Average (GPA) with the following factors: living on campus or off campus, being enrolled part-time or full-time, Hispanic citizen vs. undocumented, being first-generation college student, financial need, and transfer status. When appropriate, we also considered the role of race and ethnicity within each of the factors. In addition to the t-test to compare the average semester GPAs, we also calculated the effect size in the cases where the difference in GPA was significant. The results indicated the difference between the average semester GPA was significant, with the exception living on or off campus for Asian students. However, in all cases but being enrolled part-time or fulltime, the effect size was small. Interestingly, undocumented Hispanic students had a higher GPA than Hispanic citizens.

Keywords—student academic success, Hispanic serving institution, ethnicity, diversity, transfer students.

I. INTRODUCTION

In recent strategic plans within the College of Engineering, the University, and the state-wide higher education system, there have been calls to increase student graduation rate and retention. The graduation rate and Grade Point Average (GPA) are lower for the college of engineering students compared to other colleges at the University. For example, for the 2009 cohort the 4-year graduation rate was 8% lower for engineering students compared to their non-engineering peers and the 6-year graduation rates was 10% lower. The campus-wide GPA for students who graduated in 4-year was 3.32, while it was 2.23 for engineering students. In addition, there is an academic gap for underrepresented minorities (URM) in the college of engineering. Over the past five years, the URM students 6-year graduation rate is 13.5% lower than their non-URM peers.

Issues of retention and persistence is not unique to our University. According to the ACT National Collegiate Retention and Persistence to Degree Rates report in 2012, the current first to second year retention rate was 66.5% [1]. Specifically, four-year institutes are at around 71% while two-year institutes are at 55%. This trend of students leaving colleges continues through the student academic tenure, and 45% of students who enter college graduate after 5 years.

Despite numerous efforts to improve students' retention and success over the past 30 years, the retention rates remain steady [2].

Understanding the factors that influence student success is an important step towards increasing student retention and persistence rates. In this study, we are examining factors that are relevant to the unique context of the University to determine how these indicators influence student success. Important context that are included are: Hispanic Serving Institution (HSI), diversity, high cost of living, high levels of income inequality, and high transfer rate. Many of these factors are interrelated, for example, the cost of living impacts the income inequality of the region.

II. LITERATURE REVIEW

To perform this study we identified seven factors, related to the University's engineering context, to investigate further in terms of student success, these include: ethnicity, housing, financial aid, first-generation status, transfer status, enrollment status (full or part time), and Hispanic students who are undocumented.

In this section, we will review the university's context and the previous research on how these factors relate to student success. The elements of student success in the review are identified as GPA, retention, and graduation rates. The authors were unable to identify previous research that focus on enrollment (full/part time) or undocumented status.

A. Ethnicity and Gender

In the college of engineering, 43% of students identified themselves as Asian, 21% White, 21% Hispanic, 3% Black, 1% Pacific Islander, 0.2% American Indian, and 3% Unknown. The gender breakdown was 83% male, 15% female, and 2% unknown. There may be some ethnicities, such as Middle Eastern, and Pacific Islander, that may be incorrectly identified. We will be presenting students who identified Asian, White, and Hispanic students, since these three ethnicity groups make of the majority of the student body in the college of engineering.

In general, research has identified male students to have higher retention rates compared to their female peers [3]. The probability of persistence is lower for Latino students, and

higher for Asian students, compared to their white peers [4]. White students also have a higher retention rate compared to black students [5]. Female Hispanic students are at a greater risk of leaving college compared to Hispanic male or white student [6]. Males and/or non-minority students are more likely to graduate in STEM related degrees compared to female and/or minority students [7].

B. Housing

The city the University is located has one of the highest cost of living [8] and anecdotally, the authors know that many of the students whose families live locally, live with their parents due to high rents. There are also many students who are struggling with homelessness. This is evident in the increase of student-centered food distribution on campus, new Student Homelessness Association clubs, and an increase in library access to accommodate homeless students. Currently, university has a policy that mandates freshman students, who live over 30 miles away, to live on campus the first year.

Students' living arrangements have been seen to influence retention, academic performance, and graduation. A study of the housing arrangement of 103 sciences major students showed students proximity with other science majors increases retention [9]. Living on campus rather than off campus increases the probability of persistence to degree [4] [10]. Off campus residency also negatively influence black students' academic performance [11]. Results of interview of 34 first-year students revealed that students who do not live on campus feel more difficult to make friends or have a social life at the university [12]. Compatible friends create an emotional support system, which is important for retention.

C. First-generation Status

About 25% of the students in the College of Engineering were first-generation students, where neither of their parents had a college degree. Studies have shown that first-generation college students have lower engagement compared to non-first generation students [13]. They have lower interactions with faculty members, contribution in class discussions, and questions asked during class [13]. While some studies show different 4th year retention rates [14] and persistence to degree along with family income [4], first to second year retention rates does not differ for first-generation and non-first generations students [14]. A one-credit course for freshman students' parents at Wichita State University showed positive results on students' retention [15]. The goal of this course was to enable parents to give more useful advice and support to their college freshmen children. Students whose parents completed the course successfully, showed higher retention rates. Parents reported having insights about university environment and courses helped them to give advice to the students [15].

D. Financial Status and Aid

The City the University is located in has some of the highest levels of income inequality in the country, and the student population varies significantly in terms of financial status. One factor of poverty amongst the students is the level of food insecurity. A recent study of the students found 43% of

students have faced food insecurity, and the students who faced food insecurity were over four times as likely to get lower grades and drop courses [16]. There has been an increase of food banks aimed at students on campus. As a measure to determine economic status, we are exploring need-based financial aid through the Pell grant. Pell grant is a U.S. government grant based on student financial need. Family income has been shown to influence graduation rates. Students from higher income families are more likely to graduate than students from lower income families [5]. For female students mother's education and family income are positively related to retention [17]. Divorced or separated parents are negatively and parental education is positively related to academic success [18].

Financial aid has a significant impact on retention rates. Students who receive gift, loan, or work-study have higher retention rates; the higher the amount of the aid, the more likely the student stays in college [7] [14]. Type of aid is also important; grant or gift aid has the most positive impact on retention rates [5]. Family income influences graduation rates. Students from higher income families are more likely to graduate than students from lower income families [5]. Student's socioeconomic status is correlated to retention [4].

E. Undocumented Status

As a Hispanic Serving Institution, there are students who are undocumented but able to attend school under Deferred Action for Childhood Arrivals (DACA) immigration policy. We have not been able to identify previous studies that has examined undocumented status in terms of student performance. We want to fill this gap, as it is relevant to our university's context.

F. Enrollemt Status

At the university, 45% students attend part-time (enroll in less than 12 units), while others are enrolled full time (12 units). We have not been able to identify previous studies that has examined enrollment status in terms of students performance. Similar to undocumented status, this is relevant to our university's context.

III. RESEARCH PURPOSE AND RESEARCH QUESTIONS

The goal of this study is to investigate various demographic and academic factors that influence engineering student academic performance at a Hispanic Serving Institution, and how ethnicity plays a role in combination with these factors. Based on review of the literature, seven difference potential factors were selected: living on/off-campus, enrolled part-time/full-time, undocumented status, first-generation student, Pell grant eligibility, transfer/freshmen student. This study answers the following questions:

- What is the effect of the seven identified factors on engineering student academic performance in a Hispanic serving institution?
- Is there any difference between the findings for a Hispanic serving institution and other higher education institutions?

IV. METHODS

A. Data Source and Settings

This study used eight years of data collected from Spring 2009 until Fall 2016. The data consisted of student demographic and academic information that was collected at the time of admission and during the semesters the students were enrolled in the College of Engineering. The datasets before 2009 was missing a high percentage of student demographic information, thus were not included in this study. Overall, 60,427 entries of student-semester data were used in this study.

Students demographic information, including gender, ethnicity, citizenship status, first generation, and Pell grant eligibility, housing status (on/off campus), and academic information including semester GPA, number of credits attempted toward GPA in semester, student academic level (e.g., freshman), and transfer or freshmen students were included in this study.

From Spring 2009 to Fall 2016 12,053 students were enrolled in the college of engineering. As stated above, of the students in the College of Engineering 15% were female. Regarding students self-declared ethnicity, 43% students identified themselves as Asian, 21% white, and 21% Hispanic. Student age varied between 15 and 67, with the majority of students from 18 to 23. 25% of students were first generation students, and 35% were Pell grant eligible. 55% of students entered university as freshmen, and 37% as transfer students. Overall, the average semester GPA of students were 2.82. Student enrollment increased during this time period but the average semester GPA did not change drastically (see Fig. 1).

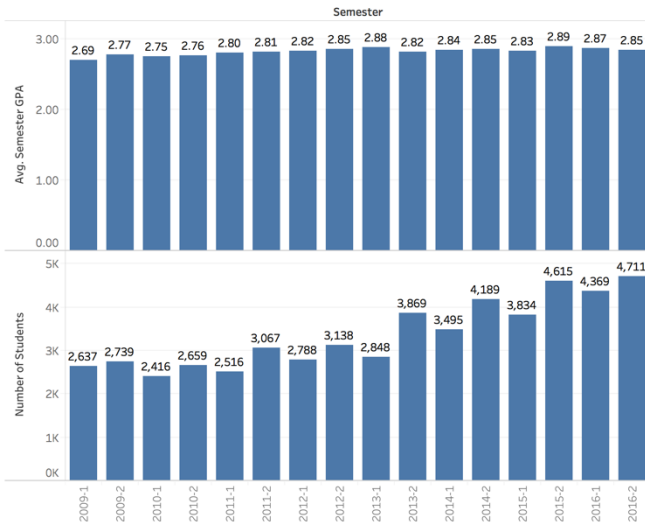


Fig. 1. Number of students and average GPA per semester (1=Spring semester, 2=Fall semester)

B. Analysis

In addition to descriptive statistics, t-tests were conducted to investigate if there is a significant difference between students average semester GPA based on housing status (for

freshmen), enrolled part-time or full-time, citizen or undocumented status for Hispanic students, first generation students, Pell grant eligibility, and freshmen or transfer students. For the t-tests, semester data for students were used. Thus, n in the t-test is the number of student-semester entries, which is greater than the number of students. In cases that the t-test results were significant, effect size was calculated to demonstrate the effect of the factor on students semester GPA.

V. RESULTS

A. Housing

The university has a policy that all non-local students (who live more than 30 miles from campus) should live on campus for the first year. Because of this reason, majority of on-campus students are freshmen. To be able to compare the effect of living on/off campus on student GPA, we only included freshmen students in this part of analysis. 46% of freshmen students lived on-campus and 54% lived off-campus. Four t-test analyses were conducted in order to examine whether freshman students' average semester GPA differs with respect to living on-campus or off campus among four groups of students: 1. All students, 2. Hispanic students, 3. Asian students, and 4. White students.

Among all students, the ones who were living on-campus (n=5,289, number of entries, which is student-semester) had an average GPA of 2.73 (SD=0.82) while the ones who were living off-campus (n=6,590) had an average GPA of 2.71 (SD=0.86). Since Levene's test indicated unequal variances (F=24.12, p<0.05), the t-test result for unequal variances was used. The GPA difference between the two groups was to be not significant (t(11558.12)=-1.35, p>0.05) (see Table I).

Among the Hispanic freshman students, those living on-campus (n=1,420) had an average GPA of 2.57 (SD=0.85) while those living off-campus (n=1,547) had an average GPA of 2.50 (SD=0.92). The t-test results for unequal variances was used since homogeneity of variances assumption was violated (F=13.62, p<0.05). The average GPA of Hispanic students living on-campus was found to be significantly higher than that of Hispanic students living off-campus (t(2964.98)=-2.33, p<0.05, d=0.08). However, the effect size found to be small based on Cohen's [19] criteria.

The average GPA (M=2.83, SD=0.78) of Asian freshman students living on-campus (n=1,880) was found to be statistically not different than the average GPA (M=2.83, SD=0.79) of Asian freshman students living off-campus (n=3,316) (t(5194)=0.045, p>0.05) assuming that homogeneity of variances was provided (F=1.97, p>0.05).

The White freshman students living on-campus (n=1,152) had an average GPA of 2.82 (SD=0.78) while those living off-campus (n=946) had an average GPA of 2.74 (SD=0.87). Levene's test indicated significant unequal variances (F=13.12, p<0.05). The t-test results for unequal variances revealed that the students living on-campus had significantly higher GPA than those living off-campus (t(1923.20)=2.144, p<0.05, d=0.10). According the Cohen's [19] criteria, the effect size was interpreted as small.

TABLE I. T-TEST RESULTS (* $p < 0.05$).

Variable	n (student- semester)	M	SD	t-test	d
Housing, all freshman students	5,289	2.57	0.82	-1.35	-
On-campus	6,590	2.71	0.86		
Off-campus					
Housing, Hispanic freshman	1,420	2.57	0.85	-2.33*	0.08
On-campus	1,547	2.50	0.92		
Off-campus					
Housing, Asian freshman	1,880	2.83	0.78	0.045	-
On-campus	3,316	2.83	0.79		
Off-campus					
Housing, White freshman	1,152	2.82	0.78	2.144*	0.10
On-campus	946	2.74	0.87		
Off-campus					
Enrolment status				47.49*	0.41
Full-time students	38,339	2.94	0.66		
Part-time students	22,087	2.62	0.87		
First-Generation, all students				-15.11*	0.14
First-generation	14,779	2.74	0.78		
Not first-generation	45,132	2.85	0.75		
First-Generation, Hispanic				-5.37*	0.09
First-generation	6,115	2.63	0.81		
Not first-generation	6,009	2.70	0.78		
Financial status, All students				-11.627*	0.10
Pell eligible	20,337	2.77	0.78		
Not Pell eligible	40,090	2.85	0.75		
Financial status, Hispanic				-7.95*	0.15
Pell eligible	5,449	2.60	0.81		
Not Pell eligible	6,675	2.72	0.78		
Undocumented Status, Hispanic				-3.20*	0.13
Citizen	10,276	2.65	0.80		
Undocumented	644	2.75	0.77		
Transfer status				-12.17*	0.11
Freshman	35,263	2.80	0.76		
Transfer	21,575	2.88	0.75		

B. Enrolment Status

55% of students were enrolled full-time, and 45% were enrolled part-time. A t-test was conducted to examine whether the semester GPA of students significantly differs by being a full-time (enrolled in 12 or more credits) or part-time student. The average GPA for full-time students ($n=38,339$) was calculated as 2.94 ($SD=0.66$) and the GPA for part-time students ($n=22,087$) was calculated as 2.62 ($SD=0.87$).

Levene's test indicated the assumption of homogeneity of equal variances was not met ($F=1778.19$, $p<0.05$). The t-test results indicated that full-time students had significantly higher GPA than part-time students ($t(36822.19)=47.49$, $p<0.05$, $d=0.41$). The effect size was interpreted as moderate [19].

C. First-generation Status

Overall 25% of students were first-generation students. But this was not evenly distributed among different ethnic groups. For Hispanic students, more than half of the students were first generation (Fig. 2). A t-test analysis was used in order to examine the difference in semester GPA scores of the first-generation students and those who are not first-generation among all freshman students. The t-test results revealed that the students who were not first-generation ($n=45,132$) had significantly higher GPA ($M=2.85$, $SD=0.75$) than first-generation students ($n=14,779$, $M=2.74$, $SD=0.78$) ($t(24348.44)=-15.11$, $p<0.05$). The t-test results for unequal variances was used for this analysis based on significant Levene's test results ($F=20.853$, $p<0.05$, $d=0.14$). Being a first-generation student or not was found to have small effect on GPA for all students [19].

Another t-test analysis was conducted in order to investigate whether there is a significant difference in GPA score of first-generation and non-first-generation students specifically among Hispanic students. The t-test results, based on unequal variances ($F=4.29$, $p<0.05$), the first-generation Hispanic students ($n=6,115$) had significantly lower GPA ($M=2.63$, $SD=0.81$) than non-first-generation Hispanic students ($n=6,009$, $M=2.70$, $SD=0.78$) ($t(12118.69)=-5.37$, $p<0.05$, $d=0.09$). Similar to all students, being a first-generation student or not had a small effect on Hispanic students' GPAs [19].

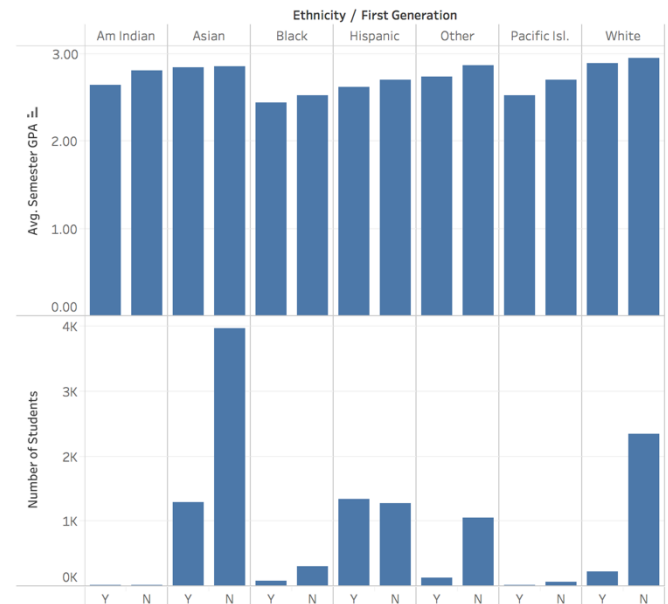


Fig. 2. Number of first generation students based on ethnicity

D. Financial Status and Aid

Overall, 35% of the students were eligible for Pell grant. Similar to first generation status, Pell grant eligibility was not evenly distributed among all ethnic groups. Hispanic students had the highest percentage of Pell grant eligibility (Fig. 3). In order to investigate whether the semester GPA of students differ with respect to being eligible for Pell grant or not, a t-test analysis was conducted. Among all students, 20,337 students were eligible for Pell and had an average GPA of 2.77 (SD=0.78) while 40,090 students were not eligible for Pell grant and had an average GPA of 2.85 (SD=0.75). The t-test results for unequal variances, due to significant Levene's test ($F=16.25$, $p<0.05$), indicated that the GPA difference between the two groups were significant ($t(39717.27)=-11.627$, $p<0.05$, $d=0.10$). Eligibility of Pell grant was found to have a small effect on GPA score [19].

To investigate whether the semester GPA of students differ with respect to being eligible for Pell grant, specifically Hispanic students, another t-test analysis was conducted. Among the Hispanic students, 5,449 of them were found to be eligible for Pell grant and they had an average GPA of 2.60 (SD=0.81), and 6,675 of the found to be not eligible for Pell grant and they had an average GPA of 2.72 (SD=0.78). The t-test results for unequal variances, due to significant Levene's test ($F=7.19$, $p<0.05$), indicated that the students who were not eligible for Pell grant had significantly higher GPA than the students who were eligible for Pell grant ($t(11451.14)=-7.95$, $p<0.05$, $d=0.15$). However the effect size was interpreted as small based on Cohen's [19] criteria.

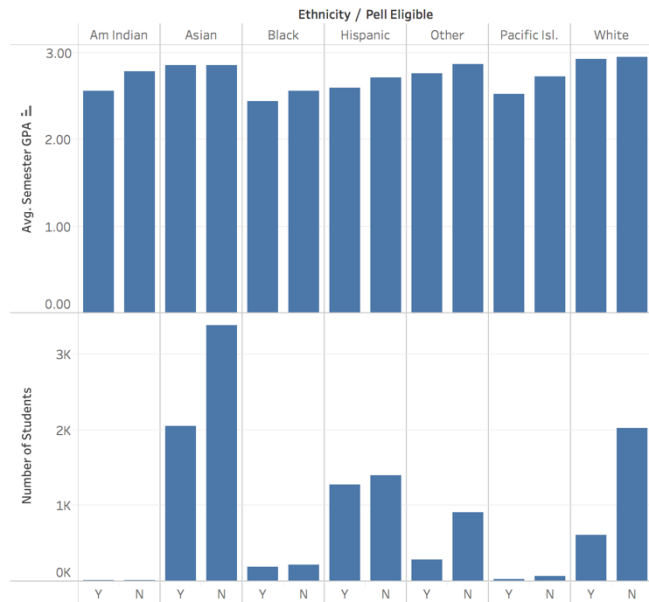


Fig. 3. Number of Pell grant eligible students based on ethnicity

E. Undocumented Status

Because 83% of undocumented students were Hispanic, we only conducted the t-test between Hispanic citizens and Hispanic undocumented students. In order to investigate

whether the semester GPA significantly differs by being a student or being undocumented among specifically Hispanic students, a t-test analysis was run. The t-test analysis results indicated that the citizen Hispanic students ($n=10,276$) had significantly lower GPA ($M=2.65$, $SD=0.80$) than undocumented Hispanic students ($n=644$, $M=2.75$, $SD=0.77$) ($t(10918)=-3.20$, $p<0.05$, $d=0.13$). However, the effect size was found to be small [19].

F. Transfer Status

55% of students entered university as freshman, and 37% as transfer students. A t-test analysis was run to examine whether the GPA scores of freshman students was significantly different than that of transfer students. The average GPA score for freshman students ($n=35,263$) were calculated as 2.80 (SD=0.76) while it was calculated as 2.88 (SD=0.75) for transfer students ($n=21,575$). Considering the significant unequal variances ($F=6.00$, $p<0.05$), t-test results for unequal variances were interpreted. Transfer students were found to have significantly higher GPA scores than freshman students ($t(45889.05)=-12.17$, $p<0.05$, $d=0.11$). Being a freshman or transfer student had a small effect on average GPA [19].

VI. DISCUSSION

The results indicated the difference between the average semester GPA was significant for all examined factors, except living on or off campus for Asian students. However, only enrollment status (part-time vs. fulltime) had a significant the effect size. In terms of university policies, we suggest the University policies focus efforts on the factors with high effect – essentially examining their campus living policy and enrollment status.

The university policy of requiring freshmen students to live on campus, which is most likely based on research at other institutions, may not be appropriate to the University students. The impact of living on or off campus either do not have any effects on student performance or the effect size is small for some ethnic groups (Hispanic and White students). At the same time, the findings highlight the importance of taking into account each university's situation in making policies. More quantitative and qualitative research is needed to investigate this issue further. For example, context of living with friends or family members may influence academic success.

Enrolment status has a moderate effect on student performance. Students who commit to school full time perform better than part-time students. Because of this, policies that allow students to study full time (e.g. through providing financial aid) will likely help students to be more successful in their education. University administrators should put forward policies that encourage students to study full time.

Although our findings related to first-generation students and financial aid status were consistent with other studies, we went one step further and calculated the effect size. Surprisingly, the effect of being first-generation student, and financial aid edibility on student performance is small. This may be because of functioning support systems such as success centers and financial aid system at the University, or overall

increase of knowledge and awareness amongst high school and university students.

Interestingly, the undocumented Hispanic students performed better than Hispanic citizens; Although effect size was small. Further research is needed to explain this trend. Possible explanations could be due to increased motivation of students, level of family pressure, or that students who do not succeed are more likely to leave.

Transfer students had better GPAs than students who started as freshmen, although the effect size was small. After finishing a couple of years at another institutions (typically a community college) these students are motivated to transfer to a 4-year institution and earn their undergraduate degree. Further research is needed to explain this trend.

VII. CONCLUSION

In this paper, we analyzed 60,427 student-semester entries from 12,053 engineering students enrolled at a Hispanic serving institution over 8 years. These students were enrolled at the college of engineering over eight years. We examined the common factors that influence student academic performance in order to identify important factors in the context of a Hispanic serving institution. Most important factor that influenced student academic success was being enrolled part-time or fulltime. Not only fulltime students had significantly higher semester GPA than the part time students, but the effect size of this difference was also moderate. For all other factors, with the exception living on or off campus, the difference in students' GPA was significant, but the effect size was small. This indicates while the GPA difference was statistically significant, this difference may not be important in practice. For living on or off campus, the difference in student GPA was only significant for Hispanic and white students, and not Asian students.

One interesting finding in this paper, that to our knowledge has not been investigated, was that undocumented Hispanic students have a significantly higher GPA than Hispanic citizens. The reasons behind this difference should be investigated.

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