WIP: Undergraduate Academic Probation First Semester and Subsequent Academic Performance

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Abstract – **This Works-in-Progress research explored academic probation inequity among undergraduate engineers. This study builds off the descriptive research, detailing the gradual increase in academic probation standards through increasing the cut off point in semester grade point average (GPA) across nine institutions with engineering programs [1]. We also know from a state-wide study in Oklahoma that a disproportionate percentage of Black students were put on probation following an increase in standards over a three-year period, 1990-1993 [2]. Accordingly, I posed the research question of whether increasing academic probation standards differentially impacted minoritized student outcomes such as academic performance the following semester.**

My framework to dissect any academic probation differential impact on minoritized populations was based on Eccles' (1983) Expectancy-Value Theory (EVT) [3]. My multi-level modeling study, utilizing the Multi-Institutional Database for the Investigation of Engineering Development (MIDFIELD), included 19 institutions with engineering undergraduate programs and analyzed the relationship between first semester probation and non-probation students and subsequent performance after probation (EVT's socializer's beliefs and behaviors), controlling for student sex/ethnicity (EVT's cultural milieu) and past performance (EVT's achievement-related past experience). One important finding was Black males not put on probation with the same first semester grade point average (GPA) did subsequently better than Black males put on probation.

My recommendations were rooted in EVT and followed the recommendations of Critical Race Theory (CRT) experts who expect more research to utilize the critical paradigm, especially in quantitative research [4-5]. I critique institutional power and policies themselves and avoided placing blame on minoritized student groups as ill-prepared or requiring remediation. Administrators should consider placing substantial time and effort addressing stereotype threat and continue to research the subgroups differentially impacted at their own institution over time.

Keywords--academic policies, quantitative methodology, critical theory, academic probation

I. INTRODUCTION

Higher education retention rates in the United States have been increasingly politicized due to the rising costs of tuition and student debt [6-7]. U.S. postsecondary retention rates have stagnated for the last few decades and resources have been increasingly directed toward student success initiative. One way researchers and practitioners have partnered to help solve this stagnation problem and improve student persistence past the first year is to examine policies and interventions such as academic advising, early warning systems, and the use of probation and suspension [1]. Brawner et al. (2010) described nine institutions within a national database, Multi-Institutional Database for the Investigation of Engineering Longitudinal Development (MIDFIELD). They found that these institutions have gradually increase the standards over time in which they place students on probation, ranging from 1.6 to 2.25 semester GPA.

Research on probation efficacy has been conducted at mostly single higher education institutions [8-9] and only a few across institutions, over time [2]. These studies failed to take a critical lens to examine any different effects the probation treatment might have on different ethnic groups or between females and male, which is necessary to fully understand the effects policies have on undergraduate students, a charge issued to higher education researchers [4, 9] specifically urging an examination at the intersection of sex and ethnicity as Black females could be doubly affected.

We know from one Oklahoma statewide study that African Americans and males were disproportionally put on probation and suspension following increasing standards over three years [2]. GPA standards in the first year were increased from 1.6 to 1.7 for first semester GPA from 1991 to 1993 across all public higher education institutions in Oklahoma. While this report found a greater percentage of Black students put on probation during and after the increase, the report did not disaggregate by sex or ethnicity when reporting their net positive outcome measured by increased retention. Two questions remain. Does probation have a positive effect on subsequent performance when students do persist from the first semester to second in engineering? Do second semester performance outcomes differ at the intersection of sex and ethnicity by probation status in engineering?

II. BACKGROUND

A. Lack of Intersectional Probation Studies

No study to date has looked at the intersection of sex and ethnicity when examining probation. Many studies have examined sex and ethnicity separately and found females performed better than males subsequently and no significant difference in performance was measured within ethnicity [2, 11]. Within engineering, an intersectional research approach utilizing multi-institutional datasets that capture student record data over time is especially important due to the small numbers of each ethnic group over time. Most studies lack

the sample size of minoritized populations to find any significant difference in regression analysis.

B. Student Deficit Framework

Many studies within the Journal of College Student Retention: Research, Theory & Practice focus on students needing remediation where the student, and not the policy, were the problem to be fixed [10, 11]. These studies made the student the problem and do not examine the policy itself and its effectiveness on increasing future student performance. While helpful to examine the design of an intervention, these studies do not examine the policy of probation itself.

C. Lack of Generalizability of Findings

A recent conference preceding paper explored the effects of probation at the U.S. Air Force Academy through regression discontinuity, finding an aggregate net positive outcome in second semester performance [12]. This kind of single institution study, while controlling for major such as Science, Technology, Engineering and Math (STEM), still may not be generalizable due to the extreme interventions instituted at this university (ex. weekend privileges removed).

D. Expectancy-Value Theory with Institutional Critical Lens

Within Eccles' EVT Framework [3], a complex set of variables predict a student's future performance or choice. This model was developed in light of differential student enrollment, based on sex, in advanced math courses in high school. Females who achieved equivalently to males enrolled at lower rates than their male counterparts. The EVT components of this complex model that I have chosen to focus on constitute the environmental variables responsible for students' development (see Figure 1). I chose these

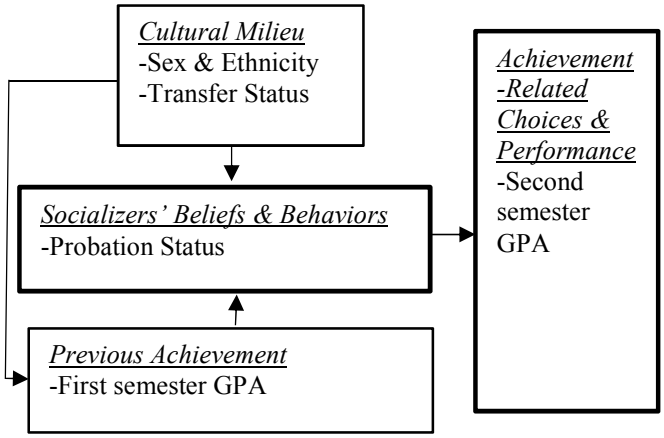

Fig. 1. Adaptation from Eccles excpectancy value model to explain probation policy influence on future performance.

variables to conduct an institutional level rather than a student as deficit critique.

E. Research Question

Is there significant interaction between sex/ethnicity and probation status in relation to second semester grade point average (GPA) for students below a 2.25, controlling for student characteristics and past performance? Does probation impact everyone similarly?

III. METHODOLOGY

A. Sample

Data came from the MIDFIELD database and contained longitudinal student record data from 1988 to the present. The database contained 19 institutions with 1,424,962 unique undergraduates who at one point were engineering undergraduates. Of those, 133,147 were in their first semester with 30,142 (23%) on probation and returning for a second semester without missing data.

B. Measures

Based on an adaptation of the EVT model (see Figure 1), I used quantitative variables from the MIDFIELD dataset which included id (unique identifier), school (unique school identifier), mean centered first term GPA (covariate), probation (variable of interest, 0=no probation first semester, 1=probation first semester), sexeth (covariate, 14 dummy variables to combine sex and ethnicity), transfer (covariate, 0=first-time first year admit, 1=external transfer admit), and rgpa (dependent variable, second semester GPA). To create sexeth variable, I combined sex (male/female) and ethnicity (Asian, Black, Hispanic/Latino, International, Native American, Other/Unknown, White) categorical variables, omitting White males as the reference variable. Only those below a 2.25 were included in the analysis as the ceiling for probationary status among the institutions [2].

C. Design

I utilized the package lmer, multi-level modeling (MLM), in R Studio software to answer the research question with students (level 1), clustered by institutions (level 2). Students were not randomly selected to be put on probation, so instead of reducing possible problems with selection bias to be able to make causal claims, my questions were instead how institutions might be able to examine treatment effects of probation, controlling for EVT's developmental factors, to examine any relationship with second semester performance. I refrained from making causal claims, just predictive statements that student success staff or administrators can utilize specific to their institution and in comparison to other institutions. Based on missing data, I conducted a listwise deletion of 507 student records and determined these student records were at random across institutions and student characteristics.

The multilevel modeling equation below represents my research question:

$$\text{Level 1: } rgpa_{ij} = \beta_{0j} + \beta_1 (cwc\_pgpa_{ij}) + \beta_2 (sexeth^{*}\ probation_{ij}) + \beta_3 (smn\_ethnicity_{ij}) + \beta_4 (transfer_{ij}) + \varepsilon_{ij}$$

$$\text{Level 2: } \beta_{0j} = \gamma_{00} + \gamma_{01}(smn\_ethnicity_{ij}) + \upsilon_{0j}$$

$$\beta_1 = \gamma_{10} + \upsilon_{1j}$$

IV. RESULTS

A. Descriptive Analysis

The dataset was obtained from the MIDFIELD dataset and was comprised of students who had ever been engineering students (n=1,424,962). Of those whose GPA were below a 2.25 in their first semester, the average second semester GPA was 2.018 (s.d.=1.163). Second semester GPA was approximately normally distributed (see Figure 2).

Similar to previous research [2], Black males and females were most disproportionately on probation (see Table 1 in Appendix A). Black males comprised 9% (n=12400) of the population as compared to 14% (n=4071) of those on first semester probation. Black females comprised 9% (n=11461) of the population as compared to 11% (n=3185) of those on first semester probation. In contrast, White females were the most underrepresented of student on probation, making up 24% (n=31,973) of the population and only 18% (n=5314) of those on probation. Other/unknown females are similarly represented within the population and probation, making up 1% of each (n=1338 and n=318 respectively).

B. Inferential Analysis

There are important results to note with regards to the predicted gains or losses in second semester GPA. For the interaction between sex/ethnicity and probation status with statistical significance, Black males (-0.05, $p < .05$), White females (-0.05, $p < .05$), and Other female (-0.24, $p < 0.001$) were predicted to have lower second semester GPAs on probation compared to those not on probation, controlling for all other factors including first semester GPA. As the treatment of probation was added to these groups, performance decreased. Said differently, comparing two people with the same first semester GPA, transfer status, and institutional ethnic makeup, for those Blake males, White and Other females performed worse second semester than those not put on probation. An important distinction, for those not on probation, was that White females (0.16, $p < 0.001$) and Other females (0.11, $p<.001$) were predicted to have higher second semester GPAs than White males whereas Black males (-0.15, $p < .001$) were lower, controlling for all other factors. Additionally, even though Black females did not have a statistically significant interaction effect, they were predicted to have a lower second semester GPA than White males, controlling for all other factors.

In terms of transfer status, undergraduates who transferred into an institution as compared to those who started as first-time, first year students were predicted to have a higher (0.19, $p < .001$) second semester GPAs, controlling for first term GPA, student characteristics and institutional variable.

V. DISCUSSION AND CONCLUSIONS

The finding in literature held for engineering programs, namely that Black engineers were the most overrepresented among those put on probation in this dataset, across multiple institutions over time. Using the EVT framework and a critical lens, I wanted to stress that cultural milieu impacts first semester GPA. Therefore, environmental conditions may have impacted Black student performance. I found that first-time, first year Black males were the most disadvantaged group through treatment of probation. Black males were the only group where 1) probationary status predicted a lower second semester GPA than not being on probation for Black first-time, first year males with the same first semester GPA and 2) those not on probation were predicted to perform lower than White males, the reference group.

A. Influential Factors

These finding regarding Black males suggest that cultural milieu (sex and cultural stereotypes) for this group may be significantly more negative and/or more prevalent than for any other group within engineering programs. The socializers' (or institutions') beliefs as communicated through probationary warning seem to have a significant impact on future performance for not just Black males but also White and Other females.

B. Probation Policy Recommendations

Instead of the traditional approach of increasing semester GPA standards, which we know will disproportionately involve more Black students, administrators might turn their attention to reducing the negative cultural milieu surrounding these already disadvantaged groups. Warning students for their poor performance (or evaluative feedback) seemed to only exacerbate the lower first semester performance among Black males, White and Other females.

As for intersectional research that suggested that Black females might be doubly affected by sex and cultural stereotypes, we do not see a significant interaction effect, which is not due to sample size as they compose a similar percentage of this dataset as Black males. More research should be conducted with Black females to understand why probation does not significantly affect their second semester performance, especially utilizing the psychological components of the EVT model (how Black females interpret and internalize the warning from probation). Lastly White and Other females could be a focus of future research as probation seems to negatively affect their future performance.

VI. FUTURE RESEARCH

Beyond subgroup research, I would suggest researchers also explore three areas not addressed by this study. First, the complexity of grade forgiveness or academic redemption as these policies vary by institution and allow students to replace past grades with a future grade [2]. This needs to be explored in more detail in the context of the MIDFIELD dataset to understand the timepoint in which the term table, where semester GPA, is captured.

Second, I would improve the variables used based on the theoretical framework, specifically adding in institutional level data that could further inform cultural milieu. This may include taking the average population of each intersection of sex/ethnicity at the institutional level over time while adding in a third level of time to the

multilevel model. I could also add in implicit bias averages by the zip code of the institution as found on Github. Lastly, I could include other national data such as National Survey of Student Engagement (NSSE) or the Student Experience in the Research University (SERU) to capture differences among institutions in regards to student experiences and engagement.

Third, I would suggest researchers utilize MIDFIELD's research on policy description over time as they continue to add institutions to the dataset.

ACKNOWLEDGMENT

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APPENDIX A

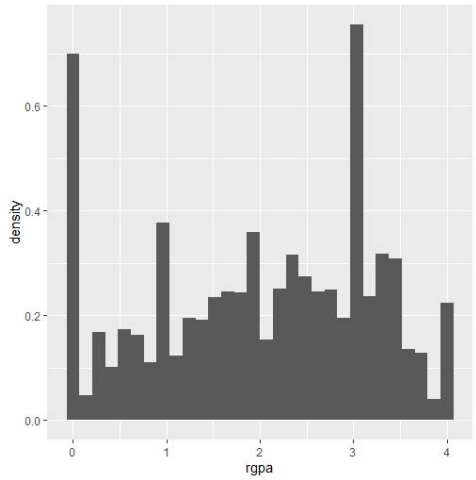

Fig. 2. Histogram of second semester GPA for students in the MIDFIELD dataset with a first semester GPA below 2.25.

TABLE I. PERCENTAGES OF UNDERGRADUATES BELOW 2.25 IN FIRST SEMESTER WHO WERE OR WERE NOT ON PROBATION, INCLUDING MEAN AND STANDARD DEVIATION OF SECOND SEMESTER GRADE POINT AVERAGE (GPA)

Category		**All students n, %**	**All students second semester GPA mean (sd)**	**Probation first semester n, %**	**Probation second semester GPA mean (sd)**	**No probation first semester n, %**	**No probation second semester GPA mean (sd)**
	All	133147, 100%	2.018 (1.163)	30142, 23%	1.458 (1.265)	103005, 77%	2.183 (1.078)
Admit Type	First Year	91811, 69%	1.955 (1.149)	19955, 66%	1.339 (1.209)	71856, 70%	2.126 (1.071)
	Transfer	41336, 31%	2.16 (1.182)	10187, 34%	1.689 (1.3373)	31149, 30%	2.314 (1.083)
Sex - Ethnicity	Male - White	57309, 43%	2.009 (1.153)	12711, 42%	1.501 (1.2695)	44598, 43%	2.154 (1.074)
	Male - Asian	3574, 3%	1.971 (1.169)	886, 3%	1.472 (1.2521)	2688, 3%	2.135 (1.092)
	Male - Black	12400, 9%	1.6323 (1.211)	4071, 14%	1.134 (1.171)	8329, 8%	1.876 (1.155)
	Male - Hispanic/Latino	3908, 3%	2.0261 (1.176)	949, 3%	1.488 (1.276)	2959, 3%	2.199 (1.087)
	Male - International	1891, 1%	2.0728 (1.203)	506, 2%	1.629 (1.25)	1385, 1%	2.235 (1.143)
	Male - Native American	578, 0%	1.9356 (1.215)	152, 1%	1.402 (1.307)	426, 0%	2.126 (1.122)
	Male - Other/Unknown	3354, 3%	1.9713 (1.36)	1020, 3%	1.537 (1.482)	2334, 2%	2.161 (1.258)
	Female - White	31973, 24%	2.233 (1.077)	5314, 18%	1.624 (1.256)	26659, 26%	2.354 (0.994)
	Female - Asian	1854, 1%	2.1691 (1.091)	353, 1%	1.567 (1.203)	1501, 1%	2.311 (1.012)
	Female - Black	11461, 9%	1.8201 (1.191)	3185, 11%	1.315 (1.216)	8276, 8%	2.015 (1.122)
	Female - Hispanic/Latino	2549, 2%	2.1857 (1.091)	488, 2%	1.670 (1.246)	2061, 2%	2.308 (1.014)
	Female - International	514, 0%	2.2371 (1.137)	95, 0%	1.700 (1.302)	419, 0%	2.359 (1.021)
	Female - Native American	444, 0%	2.0657 (1.24)	94, 0%	1.287 (1.17)	350, 0%	2.275 (1.035)
	Female - Other/Unknown	1338, 1%	2.1145 (1.24)	318, 1%	1.423 (1.36)	1020, 1%	2.33 (1.117)

TABLE II. RESULTS FOR MODELS 3 – INTERACTION OF PROBATION AND SEXETH (INTERSECTION OF SEX AND ETHNICITY).

Linear mixed model fit by maximum likelihood . t-tests use Satterthwaite's method 'lmerModLmerTest']

Formula: rgpa ~ cwc_pgpa + probation + AsianMale + BlackMale + HispMale + IntlMale + NativeMale + OtherMale + WhiteFemale + AsianFemale + BlackFemale + HispFemale + IntlFemale + NativeFemale + OtherFemale + transfer + smn_asian + smn_black + smn_hisp + smn_intl + smn_native + smn_other + probation * AsianMale + probation * BlackMale + probation * HispMale + probation * IntlMale + probation * NativeMale + probation * OtherMale + probation * WhiteFemale + probation * AsianFemale + probation * BlackFemale + probation * HispFemale + probation * IntlFemale + probation * NativeFemale + probation * OtherFemale + (probation | school)

AIC	BIC	logLik	deviance	df.resid
400115.5	400507.4	-200017.8	400035.5	132995

Scaled residuals:

Min	1Q	Median	3Q	Max
-2.7114	-0.78131	0.06004	0.77929	3.00662

Random effects:

Groups	Name	Variance	Std.Dev.	Corr
school	(Intercept)	0.02831	0.1682	
	probation	0.02039	0.1428	0.77
Residual		1.18315	1.0877	
Number of students:	133035	Number of Univ:	19	

Fixed effects:

	Estimate	Std. Error	df	t value	Pr(>|t|)	Signif.
(Intercept)	2.17E+00	1.10E-01	1.56E+01	19.801	1.72E-12	***
cwc_pgpa	3.95E-01	8.00E-03	1.31E+05	49.354	< 2.00E-16	***
probation	-8.51E-02	3.86E-02	1.81E+01	-2.201	0.040966	*
AsianMale	1.07E-02	2.17E-02	1.33E+05	0.494	0.621109	
BlackMale	-1.50E-01	1.49E-02	1.07E+05	-10.11	< 2.00E-16	***
HispMale	-4.83E-03	2.08E-02	1.33E+05	-0.232	0.816506	
IntlMale	5.12E-02	2.99E-02	1.33E+05	1.713	0.086647	.
NativeMale	-7.44E-02	5.32E-02	1.33E+05	-1.399	0.161795	
OtherMale	-1.29E-02	2.42E-02	1.30E+05	-0.531	0.595626	
WhiteFemale	1.56E-01	8.53E-03	1.33E+05	18.267	< 2.00E-16	***
AsianFemale	1.45E-01	2.86E-02	1.33E+05	5.066	4.07E-07	***
BlackFemale	-2.77E-02	1.50E-02	1.04E+05	-1.847	0.064785	.
HispFemale	7.27E-02	2.47E-02	1.33E+05	2.942	0.003257	**
IntlFemale	1.07E-01	5.35E-02	1.33E+05	1.992	0.046428	*
NativeFemale	-8.02E-03	5.87E-02	1.33E+05	-0.137	0.89135	
OtherFemale	1.13E-01	3.49E-02	1.33E+05	3.252	0.001145	**
transfer	1.92E-01	6.83E-03	1.33E+05	28.155	< 2.00E-16	***
smn_asian	-1.76E+00	1.46E+00	1.26E+01	-1.206	0.249951	
smn_black	-4.01E-01	1.43E-01	1.31E+01	-2.806	0.014753	*
smn_hisp	-3.34E-01	1.07E+00	1.30E+01	-0.312	0.760286	
smn_intl	1.57E+00	2.08E+00	1.35E+01	0.756	0.462811	
smn_native	8.47E+00	2.60E+00	2.03E+01	3.261	0.003853	**
smn_other	-1.64E+00	4.77E-01	1.61E+01	-3.431	0.003391	**
probation:AM	-3.19E-04	4.37E-02	1.33E+05	-0.007	0.994178	
probation:BM	**-5.85E-02**	**2.77E-02**	**2.53E+04**	**-2.11**	**0.034899**	*
probation:HM	-6.53E-02	4.23E-02	1.32E+05	-1.543	0.12286	
probation:IM	8.03E-02	5.80E-02	1.32E+05	1.385	0.166028	
probation:NM	-4.81E-03	1.04E-01	1.33E+05	-0.046	0.963001	
probation:OM	-2.03E-02	4.44E-02	1.06E+05	-0.457	0.647393	
probation:WF	**-4.78E-02**	**1.99E-02**	**1.31E+05**	**-2.403**	**0.016271**	*
probation:AF	-6.95E-02	6.54E-02	1.33E+05	-1.063	0.287859	
probation:BF	-1.12E-02	2.92E-02	2.88E+04	-0.385	0.700098	
probation:HF	4.20E-02	5.63E-02	1.32E+05	0.747	0.45522	
probation:IF	6.57E-02	1.24E-01	1.33E+05	0.529	0.59689	
probation:NF	-2.00E-01	1.27E-01	1.33E+05	-1.57	0.116319	
probation:OF	**-2.38E-01**	**7.13E-02**	**1.32E+05**	**-3.337**	**0.000848**	***

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Adjusted ICC: 0.034
Conditional ICC: 0.031