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Beyond SES: Individual Financial Status as a Predictor of Persistence for High-performing Undergraduate Engineering Students

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Beyond SES:
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Introduction

The significance of economic considerations and financial aid in access to and persistence in higher education is widely recognized [1-9]. In engineering education specifically, researchers have also increasingly begun to analyze economic factors in persistence and attrition of engineering students [10-13]. Our analysis builds on such recent scholarship. In particular, it explores the role that individual financial need played in the attrition of high achieving engineering students at one institution and proposes individual financial status (IFS) as an important variable for future studies.

An examination of students who left an engineering program at a private institution in the southern region of United States showed that approximately 30% of students who left had a moderate to high grade point average (GPA > 2.5). This lead to the following research question: *How does individual financial status (IFS) impact persistence of high-performing engineering students?* The paper begins with a literature review on socioeconomic status (SES), financial need, and attrition, focusing specifically on engineering education to the extent possible. Following a description of our data sources and methods, we present findings demonstrating correlation between attrition and financial need for high-performing students. The paper concludes with a discussion of policy implications of our findings and avenues for future research.

Literature Review

Engineering education is an emerging research field that draws on and interacts with the broader field of education research [14-17]. However, research on socioeconomic status (SES) constitutes only a small part of the field. When it is addressed, it is typically in the context of diversity. Even within the engineering education diversity literature, however, SES, or issues of social class, constitute only a small percentage of papers, with the vast majority of work focusing on women in engineering, racial and ethnic minorities to a lesser extent, and other types of diversity very minimally addressed [12, 18, 19].

A review of papers in the Diversity in Engineering (DinE) bibliography [20] revealed that in the context of diversity, when SES *is* discussed, authors most often connect it to poor academic performance and attrition. That is, authors note the existence of a generalized, societal-level connection between low SES and low academic achievement, and typically propose an initiative or intervention to help low SES students, often in a K-12 setting and with underrepresented minority populations [e.g., 21, 22]. In short, SES tends to be both tacitly and overtly associated with scholarship on K-12, underrepresented minorities, and a lack of academic success and persistence. These associations may be problematic in undergraduate engineering contexts, however, given our findings as well as other prior research, revealing that persistence in engineering is not necessarily related to low SES.

For example, Donaldson et al. [23] found that low SES engineering students had higher participation in engineering extracurricular activities and higher rates of persistence.

Although financial need is under-studied in engineering education retention literature, there are signs that it is becoming increasingly recognized as an important consideration. For instance, the final report from the Center for the Advancement of Engineering Education (CAEE) lists among their important questions for future research how financial challenges affect students' experiences as undergraduates [13], and others are beginning to suggest that SES be taken into account in future studies [e.g., 24]. Additionally, engineering education researchers have recently analyzed economic factors in persistence and attrition of engineering students [10-12].

More work has been done on leaving engineering than on leaving university entirely; yet such research is relevant nonetheless. Attrition is commonly assumed to be attributable to a lack of interest or academic difficulty [25]. However, studies have shown that attrition does not necessarily result from poor academic performance [26]. Seymour & Hewitt [27] found that those who left STEM majors had higher grades than those who stayed. Furthermore, looking at engineering students specifically, Bernold et al. [28] found that many of those who do leave engineering have slightly higher average grades than those who stay. Some studies have focused on financial need specifically, showing a connection between financial need and attrition [1, 27, 29]. Others, for example, Min et al. [30], suggest the possibility that the increased risk of leaving engineering could be due to financial considerations. Fleming found that students with scholarships leave engineering because of fear of maintaining a requisite minimum GPA to keep the scholarship [29]. Furthermore, those who leave engineering are more likely to work off campus for pay [31], which might suggest a link between income and attrition. Again, however, such studies are but a small part of the engineering education scholarship on persistence/retention. Given both the limitations of SES and the widespread lack of attention to financial need in engineering education literature, we suggest new constructs such as *individual financial status (IFS)* warrant further attention and policy considerations.

Methods

Context

This study utilized institutional data from the college of engineering at a small private school in the Southern region of the United States. The institution has approximately 37% of its students enrolled in the college of engineering, which offers degrees in aerospace, civil, computer, electrical, mechanical, and software engineering. The campus as a whole has 92% full-time students, is 84% male, and 86% domestic. Approximately 35% of all students reside in-state.

In the 2010-2011 academic year, 98% of all students on campus received some form of financial assistance (Table 1). Most notably, 44.1% of those students relied on loans to support their education.

Table 1. Financial Assistance used by students during the 2010/2011 academic year

Funding Type	Amount	Percent
Loans	$116,654,100	44.1%
Sponsors	$49,891,888	18.8%
Grants	$43,952,393	16.6%
Scholarships	$41,090,767	15.5%
Waiver and In-Kind	$7,430,970	2.8%
Employment	$5,722,255	2.2%

Data Sources

Institutional data was collected from the 2001 to 2010 academic years. The data included students' sex, citizenship, SAT scores, ACT scores, and high school grade point average. Included in this information are details related to students' financial need. As with most institutions, through the financial aid offices, student budgets are identified based on the tuition, housing, and other academic expenses. In addition, the expected family contribution (EFC) is included within the financial aid information. For this study, we have identified students' Individual Financial Status as the Budget minus EFC. While other studies have identified SES through the offering of school lunches at students' high schools, secondary educational district statistics, and U.S. census statistics for hometown, this study identifies IFS based on sources that are readily available through most financial aid offices, and which, we argue, are more informative in some respects. The data also included academic information such as average course load (total credit hours / number of terms enrolled), cumulative GPA at the last semester enrolled, enrollment in remedial math courses at the institution, Calculus I and Calculus II grades, and Physics I and Physics II grades.

Data Analysis

In order to address the research question: How does a student's individual financial status (IFS) impact persistence of high performing students?, the institutional data was examined for attrition using a logistic regression to identify predictors of attrition and independent sample t-tests to explore the differences between high and low achieving students.

The logistic regression was used to identify the following independent variables: sex, citizenship, SAT math, ACT math, high school GPA, IFS, average course load, cumulative GPA, remedial course enrollment (dichotomous), and grades in the first-year math and physics to predict the dichotomous dependent variable of whether students graduate or attrite for students that receive a 3.0 or higher in the Calculus I course at the institution.

The t-test requires the classification of student academic achievement by grouping students into high and low academic GPA. While a letter grade of B equates to a 3.0, a

cumulative GPA of 2.5 was identified as the cut-off for high achieving students as this GPA is the highest GPA requirement for entrance into an engineering discipline from the common freshman engineering curriculum. A low GPA is classified as less than 2.5 as these students are prohibited from advancing through the curriculum in several departments.

Findings

When looking at the distribution of cumulative GPA's of students who attrite, we found that 44% of students over a 3.0 and 67% over a 2.5 attrite from engineering. Additionally, we found that these students attrite between their second (first year, spring semester) and third (second year, fall semester) term (70%).

As summarized in Table 2, the results of the logistic regression indicated that of all the independent variables, IFS (β = 2.19E-05, $p < .05$), indicating a higher need, and the Physics II grade (β = -.614, $p<.05$) were the only statistically significant predictors of attrition.

Table 2. Regression analysis of student attrition.

Predictor	**β**	**SE β**	**Wald's χ^2**	***df***	***ρ***	**e^{β} (odds ratio)**
Sex	-.861	.664	1.683	1	.195	.423
Citizenship	.671	.536	1.569	1	.210	1.957
SAT math	-.006	.004	2.440	1	.118	.994
ACT math	.141	.088	2.562	1	.109	1.152
High School GPA	-.975	.706	1.907	1	.167	.377
IFS	.000	.000	4.465	1	.035	1.000
Avg. Course load	.088	.055	2.595	1	.107	1.092
Cum. GPA	.985	.646	2.326	1	.127	2.677
Remedial Math	-.672	.757	.789	1	.374	.511
Calculus I	.135	.465	.084	1	.772	1.144
Calculus II	-.166	.249	.446	1	.504	.847
Physics I	.049	.254	.037	1	.847	1.050
Physics II	-.614	.251	5.971	1	.015	.541
Constant	-.160	3.180	.003	1	.960	.852
Overall model evaluation						
-2 Log likelihood			184.8			
Cox & Snell R^2			.154			
Nagelkerke R^2			.218			

A comparison of mean IFS between students who attrite with high cumulative GPA's and those with low cumulative GPA's revealed no statistical significance (Table 3). However, as shown in Table 3, students with higher GPA's left statistically sooner and had statistically higher average course loads during their enrollment.

Table 3. Statistical comparison of high and low performing students.

	GPA < 2.5	**GPA > 2.5**	
SAT math	578	622	**
HS GPA	3.2	3.5	**
IFS	$21,160	$19,139	
Avg. course load	7.3	10.8	**
Term Left	4.4	3.3	**

** $p < .001$

Further evidence that IFS is a contributing factor to these successful students' attrition is seen in other analyses of students that graduated from the institution, but changed majors. Through this examination there was no statistically significant difference in IFS for those that left engineering but graduated from the institution. Additionally, an examination of the exit surveys of attrite students supports the findings from the statistical examination. In these surveys, students that left the institution indicated that they were leaving to pursue academic opportunities closer to their hometown. An examination of student trends indicated that those who left the institution and continued to attend college enrolled in public institutions closer to their hometown, which is anecdotally indicative of lower tuition and cost of living.

Policy Implications & Future Work

Given the limitations of SES in understanding engineering student retention specifically, and given the fact that financial need is understudied, we propose the term *individual financial status* (IFS) be used to promote future research. This terms calls attention to the fact that an individual student's ability to finance their education can be independent from family SES. We suggest that IFS is a factor that warrants further attention by scholars and administrators concerned with attrition from engineering programs. However, it should be noted that this suggestion is in no way intended to deny the significance of the complex relationships between SES and education in our society or the need to increase recruitment and retention of low SES students.

Our analysis indicated that the IFS of a student enrolled in engineering can be a predictor of academic persistence at small private institutions. The findings indicated that students with a higher need are quicker to attrite. Since the Physics II grade is also a predictor of academic persistence, several hypotheses can provide insight. One possible explanation is that the students who attrite arrive at college on an academic scholarship that requires

them to maintain a 3.0 or higher. Due to the difficulty in the higher level physics courses, these students choose to leave engineering despite having qualifying grades to proceed at the institution. Indeed, as mentioned above, this was found to be the case at other institutions[29]. Another possible hypothesis is that the students with higher need are quicker to leave the university as they recognize that the monetary requirements to persist outweigh the risk of not completing the degree or failing to receive the requisite GPA.

These findings should lead to further exploration of the role that scholarships or grants play in the persistence of high achieving students who are limited by their individual financial status. They should also prompt financial aid policy changes that reflect the significance of IFS. However, prior to suggesting concrete policy recommendations that would be appropriate across a range of institutions, further research is needed. In order to further support and validate the findings from this study it is recommended that future studies compare these findings to public institutions with lower tuition and more opportunity and access to financial assistance. Such comparisons would shed light on the role that IFS plays in the persistence and attrition of high-performing engineering students at various types of institutions. Finally, regardless of institution type, we recommend that financial aid officers and policy developers recognize the importance of helping students navigate financial aid processes. In other words, the implementation of financial aid programs is insufficient: research shows that students struggle to understand and navigate their financial aid options and the requisite paperwork.[32-35] Such challenges may therefore limit the efficacy of any policy changes enacted if they are not adequately addressed.

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