2006-1336: THE ROLE OF ACADEMIC PERFORMANCE IN ENGINEERING ATTRITION

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The Role of Academic Performance in Engineering Attrition

I. Abstract

The role of cumulative grade-point average (GPA) in student decisions to remain in or leave engineering is studied by comparing and contrasting the GPA distributions of engineering students who withdrew from the university or changed majors from engineering (*leavers*) to those of students who graduated in engineering (*stayers*). Student record data for 39,240 engineering students at the nine SUCCEED universities from 1987 to 2002 are used to compute the distributions, determine GPA differences between the two groups of students, identify the trends of each distribution, and study the difference between them over time. The cumulative GPAs of *leavers* and *stayers* are compared after completion of the same number of semesters. The population includes first-time-in-college undergraduate students who matriculated in engineering between Spring 1987 and Fall 1996 and either graduated in engineering or departed an engineering degree program prior to Spring 2002. The comparisons reveal clear and contrary evidence to other work that suggests that *leavers* and *stayers* are academically equivalent. The average GPA of *leavers* at the semester of departure was 2.31 compared to 2.99 for the *stayers* enrolled in the same semester. Further, the high percentage of students leaving engineering with GPA over 3.0, in the range 20% to 35% depending on semester of departure, suggests that approaches targeting aspects other than improving students academic performance are necessary to reduce attrition in that population. We note that students still leave engineering after eight semesters with a GPA over 3.0, pointing to the need for qualitative research of that population to learn if they are leaving because the early curriculum failed to give them an accurate impression of what lay ahead. There is also evidence that students who are the least likely to succeed in engineering are the least aware of their predicament, which has implications for engineering advising and academic policymaking.

II. Prior research on predicting engineering attrition

The graduation rate of undergraduate students who matriculate in engineering is not much different from that for the general student population, and the rate increases significantly after students reach a 'threshold' of progress in engineering.[1] The pool of students graduating high school with sufficient momentum in science and mathematics for likely success in engineering, however, is limited, thus making improvement of graduation rate a focus for the engineering education community. As summarized below, previous studies have focused on the admissions criteria (i.e., understanding how pre-existing factors predict success) and on retention factors (i.e., understanding why students leave engineering).

There has been considerable study of pre-college factors that predict retention, including standardized test scores,[2,8,9,10,11] academic performance in high school,[2,4,10,11,12,13,14,15] gender,[2,11,22] ethnicity,[11,22] students age,[10] rural or urban setting of high school, and parents education and economic status.[37] Unfortunately, there has been less study of predictors of graduation or persistence in engineering after matriculation. A better understanding of the post-matriculation factors that influence student migration out of an engineering degree program would help suggest improvements in advising systems and modifications to curricula. Post-matriculation factors that have been studied include ethnicity, gender,[11] institutional specific metrics (e.g., institutional size, type (Carnegie classifications), or control (public vs. private),[3,4,5] institutional selectivity,[6,7] faculty to student ratio or class size,[5] student body and racial climate,[16,17] financial aid,[17,20,21] enrichment programs,[17] number of accredited engineering programs,[23] and number of student support programs[24]), and student-specific factors such as course performance (1st semester, freshman year, math and science)[27-29], student involvement and effort,[13,18] student academic and social integration,[19] and student perceptions and attitude[24,25,26]). Among these factors and as reported for high school GPA, the existence of a correlation between college GPA and persistence or graduation in engineering is widely reported. The study by Budny *et al*., based on longitudinal data (1981 to 1993) for engineering students at Purdue University, reported a value of the Pearson correlation between engineering retention and 1st semester GPA of 0.49 as compared to 0.22 for high school GPA and 0.18 for high school rank.[27] Other studies reinforce the importance of GPA performance in the freshman year. The results of Lebold and Ward suggest the best predictors of engineering persistence were the first and second semester college grades and cumulative GPA.[28] They also reported that students' self-perceptions of math, science, and problem-solving abilities were strong predictors of engineering persistence. In another study by Budny *et al*. examining the effect of specific first-year courses taken by engineering students, they again found a strong correlation between first-semester GPA and graduation rate.[29] Some correlation of GPA and engineering retention is anticipated based on the fact that students will lose merit-based scholarships if the GPA drops below 3.0 and cannot graduate with a cumulative GPA below 2.0. A high student GPA should also reflect comprehension and satisfaction with the academic subject and thus discourage migration to another discipline. In contrast to these conclusions, Seymour and Hewitt reported results from a qualitative study that indicated that students leaving engineering were academically no different from those that remained,[17] noting that students left for reasons relating to perceptions of the teaching quality, institutional culture, and career aspects. Thus the importance of college GPA as a factor in engineering attrition is less clear. Further clouding the issue is the tendency of poor performance to be accompanied by poor metacognitive ability to accurately estimate ones own abilities.[36] The inflated self-assessment that results can be manifested as increased persistence. It is also possible that some students with high GPAs are not being sufficiently challenged, motivating students to migrate.

One possible confounding condition is that most previous research studies have taken a snapshot approach and focused on differences between those who persist in engineering and those who depart an engineering degree program at one particular point in time. Students leave engineering continuously and the relative importance of the contributing factors may change with time. For example, third year students may be reacting to the discipline–specific coursework and reevaluating the suitability of an engineering career. In contrast, first year students are more likely to be in a more exploratory mode and assessing the suitability of an engineering career on other factors such as enjoyment of non-engineering courses, peer pressure, and work load. A time dependency in student GPA distribution has been found in engineering and other disciplines. For example, Ishitani assessed GPA performance of first generation college students, with first generation college students being defined as college students whose parents did not graduate from college. Based on descriptive statistics, it was observed that further into the study, a higher percentage of first generation college students had a GPA of 2.0 or higher.[30] Levin and

Wyckoff gathered data on 1043 entering freshmen in the College of Engineering at Pennsylvania State University.[15] They developed three models to predict sophomore persistence and success at the pre-enrollment stage, freshman year, and sophomore year. The freshman year model identified the best predictors of retention as grades in Physics I, Calculus I and Chemistry I. In the sophomore year model the best predictors of retention were grades in Calculus II, Physics II and Physics I. They noted that predictors of retention were dependent on the students' point of progress through the first two years of an engineering program. These results support the contention that the reasons that students leave at different progress points in their studies may differ to some degree, and understanding these differences will allow better targeting of advising and remediation efforts.

The focus of this work is to compare two time-dependent GPA distributions, one for students who leave engineering and another for those who eventually graduate in engineering. Our study examines cumulative GPA distributions of students at the semester of departure from an engineering degree program as a function of the departure semester. In this study, approximately 15 years of data for engineering students of nine universities were used to investigate differences between engineering students who migrated out of engineering in a particular semester and those who persisted to graduation. For each cohort, the study spans 12 consecutive semesters, investigating the GPA distributions of engineering students who leave at different number of cumulative enrolled semesters. To provide additional insight, these GPA distributions are compared with the GPA distributions of those students who eventually graduated in engineering at the same cumulative semester progress points. It is contended that a better understanding of the characteristics of students leaving engineering along the entire range of academic progression should provide insight into approaches to improving student retention, and aid the counseling and advising of students seeking an engineering degree. The multi-institutional nature of our data increases the generalizability of the conclusions, while the size of the database improves the statistical significance of the results. Furthermore, the longitudinal nature of the data permits study of the passage of time both chronologically and in terms of semester completion.

III. Data and Nomenclature

This study uses the Southeastern University and College Coalition for Engineering Education (SUCCEED) longitudinal database (LDB)[11,31-34] to identify students who migrate away from an engineering degree program and those that graduate in engineering, and compare their grade-point averages semester by semester and by cohort. The LDB contains data from eight colleges of engineering involving nine universities: Clemson University, Florida A&M University, Florida State University, Georgia Institute of Technology, North Carolina A&T State University, North Carolina State University, University of Florida, University of North Carolina at Charlotte and Virginia Polytechnic Institute and State University. To protect the rights of human participants, each university is assigned a letter that is only known by the researchers involved in the study.

The following nomenclature is used consistently in this study to define the student populations.

- *Stayers:* Undergraduate students who matriculated in an engineering field as defined in the Classification of Instructional Programs by the National Center of Educational Statistics[38] in the nine SUCCEED institutions between Spring 1987 and Fall 1996 and graduated in an engineering discipline in or prior to Spring 2002. Students who change major from one engineering discipline to another engineering discipline and graduate are included in the *stayers* population. The population also includes those students who matriculated in engineering but had a period of non-enrollment at the institution or a temporary non-engineering major but eventually returned to engineering and graduated in or prior to Spring 2002.

- *Leavers:* Undergraduate students who matriculated in an engineering field in the nine SUCCEED institutions between Spring 1987 and Fall 1996 and left the engineering field in or prior to Spring 2002. The *leavers* population includes those who migrated out of engineering into some other non-engineering discipline, as well as those who left the institution entirely.
- *Excluded Population:* Students who transferred from another institution (e.g., a community college or another 4-year institution) and students who matriculated in another field but later entered engineering are not included in this study. The study also excludes students who matriculated in engineering but had neither left engineering nor had graduated within six years. This is a small population, but it would be inappropriate to categorize them as either *stayers* or *leavers*.
- *Matriculated Engineering Student:* A student who either directly matriculated in a specific engineering discipline or a general engineering degree program first and then transitioned to a specific engineering major one or more semesters later.
- *Semester:* The academic year is segmented into 2 semesters, Fall and Spring, to better compare student academic progression (i.e., 2 semesters is 1 academic year). The Fall semester consists of students enrolled in the Fall semester or Fall quarter. The Spring semester includes students enrolled in the Spring or Summer semesters, or the Winter, Spring, or Summer quarters. For students who take courses in the Summer semester or Summer quarter(s), his/her cumulative GPA at the end of the Summer is used as the cumulative GPA for the Spring semester of that academic year. Semester 1 is the first semester of enrollment and can be either the Fall or Spring term as defined above. Non-enrolled semesters do not add to the number of semesters tracked in this study.
- *Cumulative GPA:* Grade point average for all courses taken at the University as obtained directly from the SUCCEED LDB. When a cumulative GPA for a student is missing, the Census GPA at the beginning of the following semester for that student is used. The census GPA is the cumulative GPA at census point of a semester, typically two weeks after the start of the semester, when enrollments are considered stable.
- *19xx Cohort:* The group of students who matriculated in an institution in a common academic year beginning in the 19xx Fall term and the following Spring term.

Excluding students who matriculated after Fall 1996 allowed study of only those students who had at least 6 years (12 effective semesters) of opportunity to graduate in an engineering field (database is populated through Spring 2002). The appropriateness of using a 6-year cutoff is well established. Our previous study[11] also supports the choice of six-year cutoff.

IV. Statistical Comparison of *Stayers* and *Leavers* GPA

We first investigated whether there is a statistically significant difference between the GPA of *leavers* who depart after a given semester and that of *stayers* enrolled in the same semester. Conventionally, such a task could be accomplished by using the *t* test for independent means, if some underlying assumptions are met: independence, normality, and homogeneity of variance. The GPAs of the *stayers* and *leavers* can be considered independent because *leavers* GPAs are not directly related to the GPAs of *stayers* as they are not paired in any manner. Additionally, the *t* test is robust to the violation of normality assumption given the large sample size of this study. The third assumption for the use of the *t* test, however, requires that the variances of the two groups are equal. Based on the results of the tests for equal variances produced by the PROC TTEST procedure in SAS, the *stayers* group and *leavers* group have unequal variances for semesters 1 through 10, and have equal variances for semesters 11 and 12. While the *t* test is robust to heterogeneity of variance if the groups being compared have equal number of participants, that is not the case in this study. Therefore, for semester 1 through 10, the usual *t* test is not appropriate, and Satterthwaite's *t* test is used instead. This test computes an approximate *t* value based on the assumption that the variances of the groups are unequal.

Table 1. Statistical Comparisons of *Stayers* and *Leavers* GPA

Semester	*Leavers* this semester	*Stayers not yet graduated*	Avg GPA of *Leavers* (sd)	Avg GPA of *Stayers* (sd)	*t**	Satterthwaite's *t**
1	4219	19048	2.31 (0.90)	3.08 (0.57)	NA	52.81 (p < 0.0001)
2	3391	19046	2.19 (0.85)	3.05 (0.60)	NA	57.2 (p < 0.0001)
3	3432	19046	2.25 (0.72)	3.01 (0.55)	NA	58.11 (p <0 .0001)
4	2517	19032	2.23 (0.61)	2.98 (0.54)	NA	58.26 (p < 0.0001)
5	1777	18998	2.29 (0.58)	2.98 (0.53)	NA	47.91 (p <0 .0001)
6	1247	18469	2.36 (0.59)	2.97 (0.52)	NA	35.16 (p < 0.0001)
7	984	17494	2.43 (0.61)	2.97 (0.52)	NA	27.08 (p < 0.0001)
8	971	14312	2.59 (0.60)	2.94 (0.51)	NA	17.89 (p < 0.0001)
9	614	11910	2.49 (0.58)	2.93 (0.51)	NA	18.47 (p < 0.0001)
10	501	7783	2.53 (0.58)	2.88 (0.51)	NA	13.38 (p < 0.0001)
11	282	5253	2.37 (0.52)	2.92 (0.53)	17.08 (p < 0.0001)	NA
12	257	2484	2.56 (0.54)	2.92 (0.56)	9.90 (p <0 .0001)	NA

* For semesters 1 through 10, the equal variance assumption of the *t* test is not met, so Satterthwaite's *t* test for unequal variance situations is reported instead.

** The total number of *leavers* is 20,192, and the total number of *stayers* is 19,048. The overall average GPA of *leavers* is 2.31, and the overall average GPA of *stayers* is 2.99.

The results in Table 1 show significant differences in average GPA between *leavers* and *stayers* in all 12 semesters. For semester 1 through 10, the significance is supported by the results of the Satterthwaite's *t* tests, and for semesters 11 and 12, the significance is supported by the results of the usual *t* test. It is noted that all p-values are < 0.0001.

V. GPA Distributions Examined and Compared

To capture the characteristics of GPA distributions, the frequency of different levels of cumulative GPAs was computed with a bin size of 0.1. Each bin contains students with GPA greater than or equal to the lower limit, but less than the upper limit. By "rounding down" it is easier to observe the potential impact of thresholds at a GPA of 2.0 and 3.0. Specifically, a GPA of 1.99 is below the 2.00 required for graduation, and is placed in the bin labeled 1.9. As a result of this approach, the 4.0 bin contains only those students with a perfect 4.0.

Several sets of GPA distributions were tabulated for comparison purposes. The first set of GPA distributions is the cumulative GPA of *leavers* at the semester of departure for semester 1 through 12. Although the GPAs are cumulative to the end of the designated semester, these distributions are not cumulative, that is, each graph only contains *leavers* who left at the end of the specified semester. The population of students who left after one semester is not included in the population of students who left after two semesters.

The second set of GPA distributions calculated is the cumulative GPA of *stayers* still enrolled at semesters 1 through 12. Graduates are dropped from the population after graduation to observe differences related to time-to-graduation. A third set of distributions was calculated by dividing the number students leaving in each range of GPA divided by the number of all students (*stayers* and *leavers*) enrolled in that semester in engineering in that GPA range. Thus, these distributions represent the fraction of students in each GPA range who leave at the end of that semester, or the likelihood of a student with a particular GPA of leaving engineering.

VI. Results and Discussion

Whereas research by Seymour and Hewitt indicates that *stayers* and *leavers* are academically equivalent,[17] this study shows clear and contrary evidence for a large population over a 15-year time span. The *stayers* (average GPA 2.99 out of 4.0) outperform *leavers* (average GPA 2.31 out of 4.0) consistently for all 12 semesters. (While average is used, the median never differs from the average by more than 0.1.) It might be hypothesized that the *leavers* doing the best academically would leave in the early semesters, yet as shown in Table 1 the average GPA of *leavers* increases slightly with semsester, presumably due to the 2.0 requirement for satisfactory progress that forces a segment of the population to leave in earlier semesters.

Our results, therefore, are more consistent with those of Budny *et al.*[27], who note that first semester GPA correlates with retention. This is consistent with our observation that students with higher grades tend to stay and students with lower grades tend to leave. Without the supporting evidence provided by our study, the correlation observed by Budny *et al.* could result from the restriction of the range of GPA, that is, the fact that students with a GPA less than 2.0 are eventually forced to leave engineering (or to leave school entirely) could create a correlation where there might not otherwise be one. Our work in combination with that of Budny *et al.*[27] provides evidence that the relationship of GPA and retention is more robust. We hypothesize the causal link that student self-efficacy improves with academic success and self-efficacy leads to improved retention. There is research to support both of these causal links.

To capture a sense of the probability that a student will leave engineering in a particular GPA bin, the percentage of students who actually leave with a cumulative GPA in that bin relative to the total number of opportunities to generate a *leaver* in that bin (i.e., number of occurrences over all semesters of a cumulative GPA in that bin) was calculated. The results are shown in Figure 1 for all *leavers* over the full 12 semester period. For example, the 33% value shown in the 4.0 bin in Figure 1 is the total number of *leavers* in the study who left with a 4.0 divided by the total number of students with a cumulative GPA of 4.0 at the end of semester 1 plus the number at the end of semester 2, ….., plus the number at the end of semester 12. Thus students with multiple semesters of 4.0 are counted multiple times. Below the 2.0 threshold, academic policy dictates that nearly 100% leave engineering. Above a GPA of 2.0, the percentage leaving engineering decreases monotonically until above a GPA of 3.0, at which point 20 to 35% of the students in the ≥ 3.0 bins leave engineering. Although Figure 1 shows percentages, the notably higher percentage of students leaving at a GPA of 4.0 is still explained by range restriction.

Engineering attrition is concentrated in the first two semesters, when range restriction results in a prevalence of students with a GPA of 4.0, so *leavers* are over-represented in that GPA range. Given that 20 to 35% of students in the higher GPA bins leave engineering, the opportunity to affect the attrition of these high-performing students is limited. A 2004 study showed that about 15% of students with a GPA above 3.0 leave engineering and change majors at least one more time before graduating.[35] If about 15% of the students leaving engineering with a GPA above 3.0 are on a journey of educational exploration, only 5 to 15% of this population can be affected by intervention.

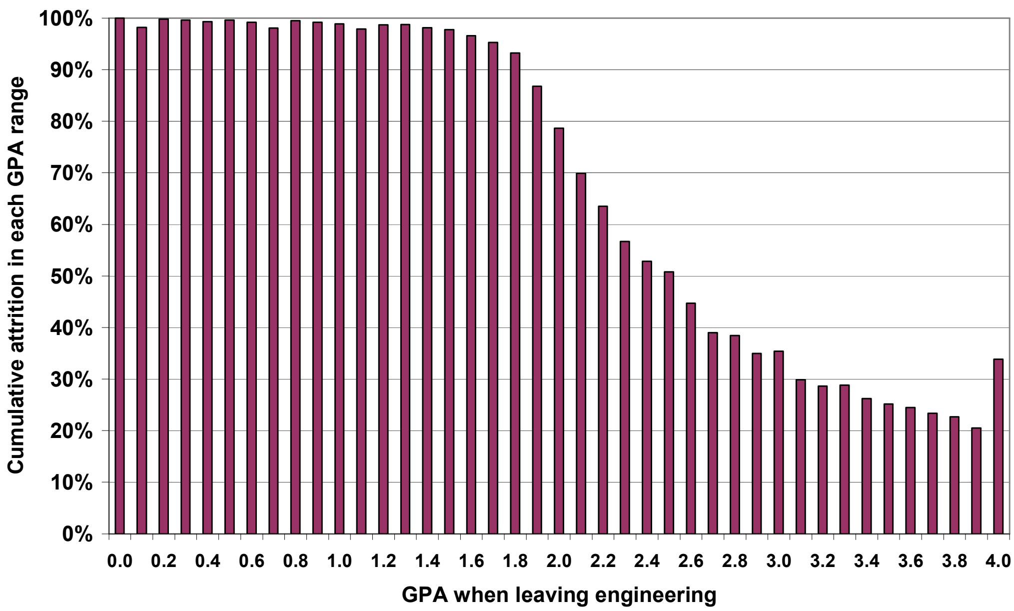

Figure 1. Cumulative Percentage of Students Leaving Engineering by Range of GPA over the studied 12 Enrolled Semester Period (total number of *leavers* = 20,192)

A time series of 12 graphs was reviewed showing the number of students who left engineering in various semesters sorted by the grade-point average of the students in the semester they left. Of those 12 graphs the ones for semesters 1, 3, 4, 5, 8, and 12 are shown in Figures 2-5. Figure 2 shows the distribution for students leaving in the 1st semester. While graphs of large datasets are usually smooth,

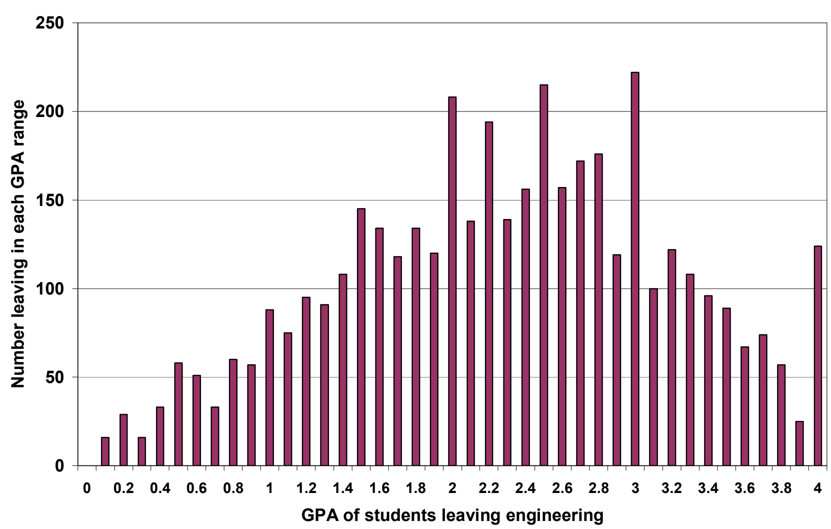

Figure 2. Frequency of GPA among *leavers* after one semester (n = 4,219).

the first semester graph here is more characteristically jagged. Because grades are issued at specific values (i.e., 0, 1, 2, 3, 4 and possible +/-) and credit hours are integers in a narrow range, certain GPA combinations (1.5, 2.0, 2.5, etc.) are more prevalent among students with few cumulative credit hours. The peak at 4.0 is also due to range restriction, comprising students who would earn higher grades if possible. While GPA is generally treated as a continuous variable in large samples, this suggests that a correction must be applied to account for this systematic variation.

As shown in Figures 3 to 5, the discontinuity and the concentration of students at a GPA of 4.0 are not present or at least less prevalent in later semesters. There is also a reduction in the variability of the distribution in later semesters as indicated by the values of the standard deviations listed in Table 1. Figure 3 at right shows three graphs, all drawn to the same scale, showing the frequency of GPA for students leaving engineering after 3, 4, and 5 semesters, respectively. Recall from Table 1 that the average of the distribution remains nearly constant throughout this range.

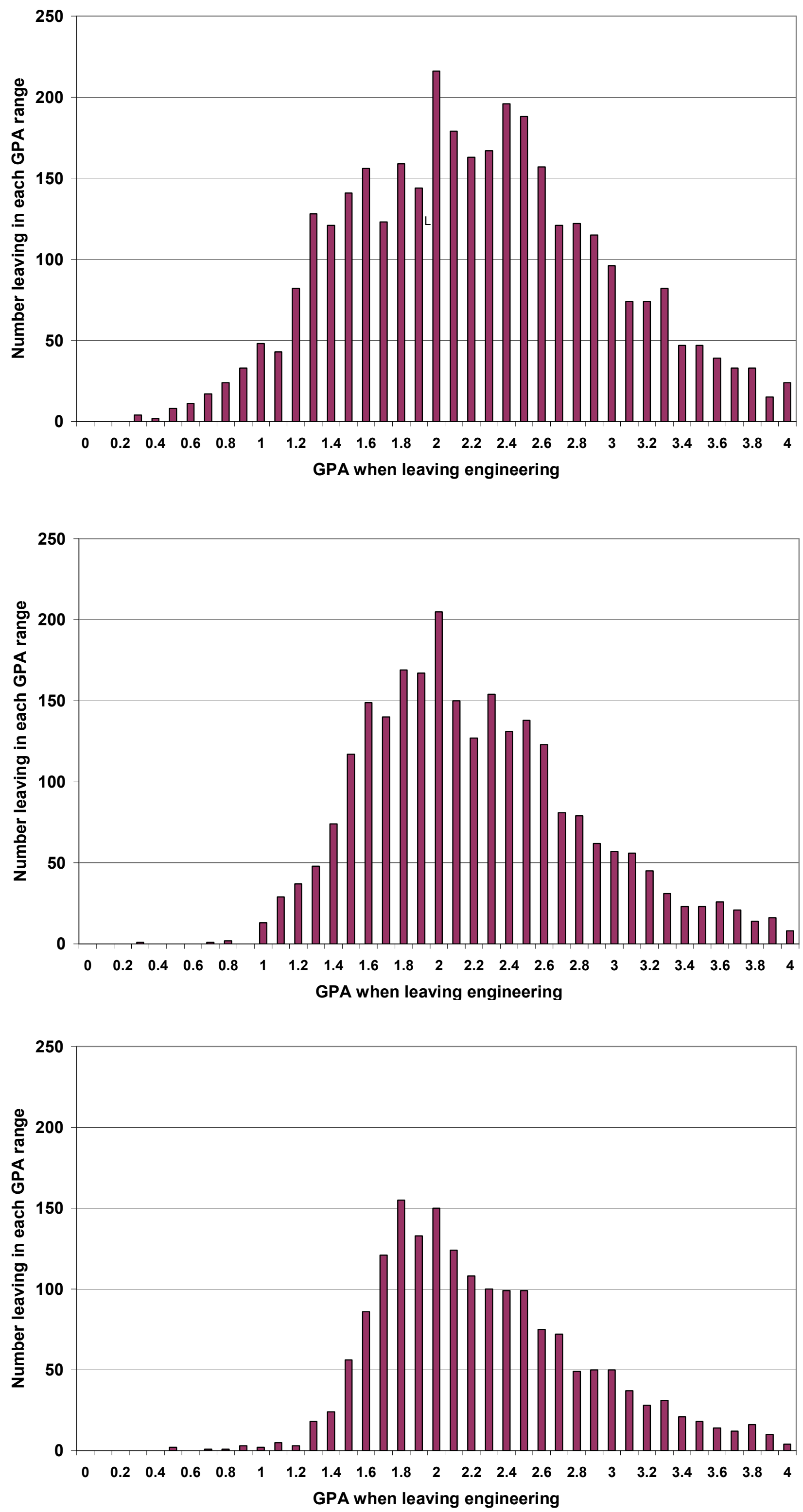

Figure 3. Frequency of GPA among Students Leaving Engineering after 3 (n = 3,432), 4 (n = 2,517), and 5 (n = 1,777) Semesters

By semester 8 (Figure 4), there is a particularly pronounced cutoff around a GPA of 2.0, as students with lower GPAs are not permitted to continue. Figure 5 shows that students doing well academically are leaving even as late as semester 12, although their number is significantly reduced. These may be students who cannot continue due to personal circumstances. If any are leaving because engineering is not what they expected, it would underscore the importance of authentic early experiences. Cooperative learning and service learning remain important, therefore, not only because they are useful pedagogically, but also because they are authentic in their representation of engineering practice.

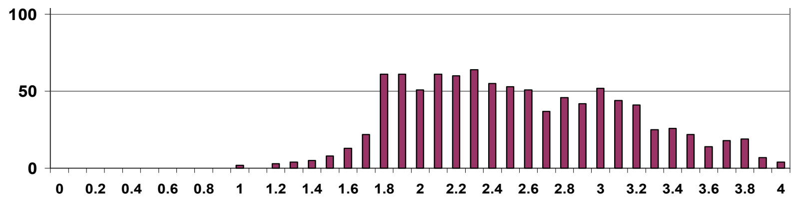

Figure 4. Frequency of GPA among Students Leaving Engineering after 8 Semesters ($n = 971$).

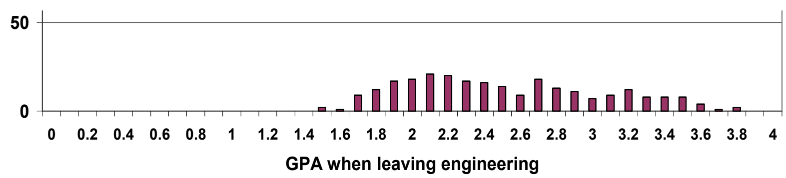

Figure 5. Frequency of GPA among Students Leaving Engineering after 12 Semesters ($n = 257$).

Figures 6 and 7 show GPA of *stayers* after semesters 1, 3, 4, and 5. There is still a concentration at 4.0 in the 1st semester, a higher average GPA, and a notable cutoff near a GPA of 2.0.

A study of the GPA of engineering graduates after semesters 3, 4, and 5 (all shown in Figure 7) show that, as with the *leavers*, the number of students with a GPA of 4.0 quickly dissipates. The distribution after semester 3 (Figure 7, top) shows that the lower tail of the distribution is notably reduced. The three graphs taken together show a reduction in the spread of the distribution similar to that of the *leavers* as revealed in Table 1. Here, the *stayers* become more and more like a "typical" *stayer*.

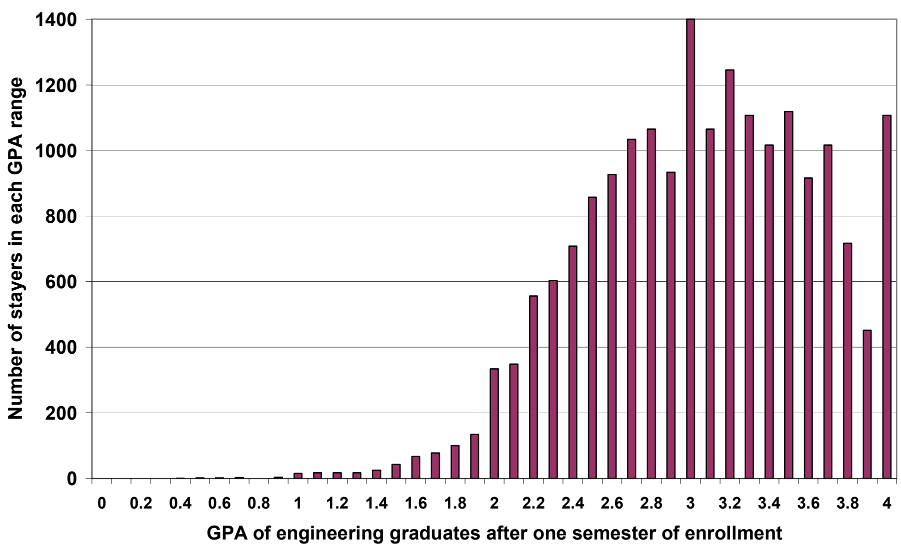

Figure 6. Frequency of GPA among Engineering Graduates after Semester 1 (n = 19,048).

Together, the GPA distribution of *stayers* and *leavers* convey the likelihood of attrition in a given semester for a given GPA. Figure 8 shows *leavers* as a percentage of all students in each GPA range at the end of the first semester. A clear transition at 2.0 is visible.

We had hypothesized a transition at 3.0 a common cutoff for scholarships and, eventually, a de facto threshold for future education and employment opportunities. While it appears that there may be a more subtle transition at a GPA of 3.0, we reserve study of that phenomenon for further study.

Figure 9 shows the fifth semester results, at which point 100% of students with

GPA 1.1 or lower leave engineering (including some bins with no data because all those students left already). From GPA 1.2 to GPA 1.5, students with lower GPA are ***less*** likely to leave engineering. Above GPA 1.5, the distribution is more what we would expect—students with higher GPA are less likely to leave. The data look as if they might be normally distributed, except

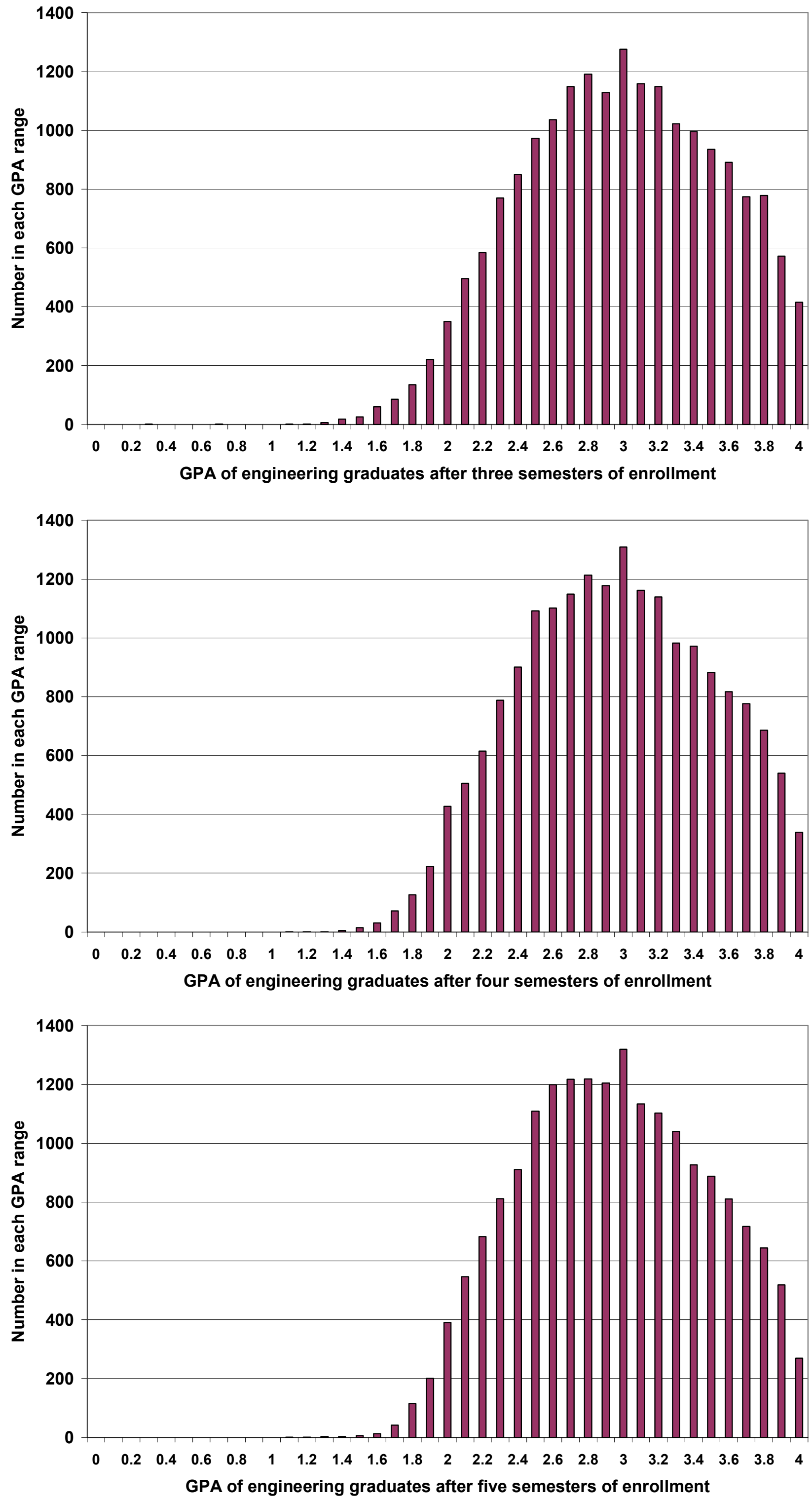

Figure 7. Frequency of GPA among Engineering Graduates at Semester 3 (n = 19,046), 4 (n = 19,032), and 5 (n = 18,998).

that the lower tail is affected by academic policies. For this to occur, students at certain low (sub 2.0) GPA levels must be less likely to leave engineering than students with higher GPAs.

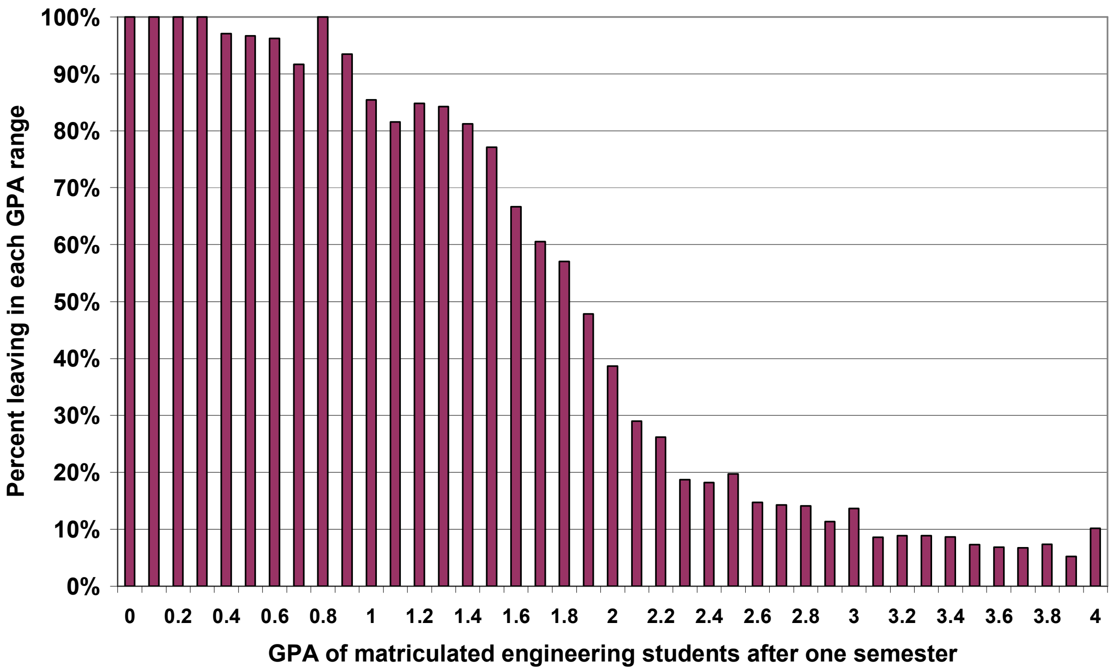

Figure 8. Percent Leaving Engineering of Those in Each GPA Range after Semester 1 (n = 4,219, N = 23,267)

The distribution shape is apparent in all the semesters that follow (Figure 10 shows semester 10 for comparison). We hypothesize that those students in the lowest GPA range have exhausted their ability to appeal and stay in school, whereas there is a group of students who are doing just well enough to stay in school with the help of safety nets, yet are not fully aware that they are doing so poorly in engineering that they will unlikely graduate. These students are what Kruger and Dunning term “unskilled and unaware of it”. They found that people who are the

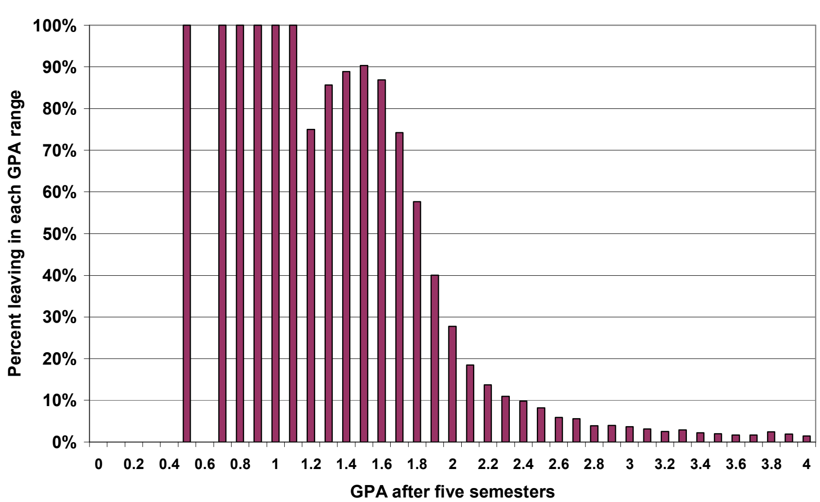

Figure 9. Percent Leaving Engineering of Those in Each GPA Range after Semester 5 (n = 1,777, N = 20,775)

least competent are also the least aware of their shortcomings. In fact, their research showed that all subjects, even the least competent, estimated their competence as being above average.[36]

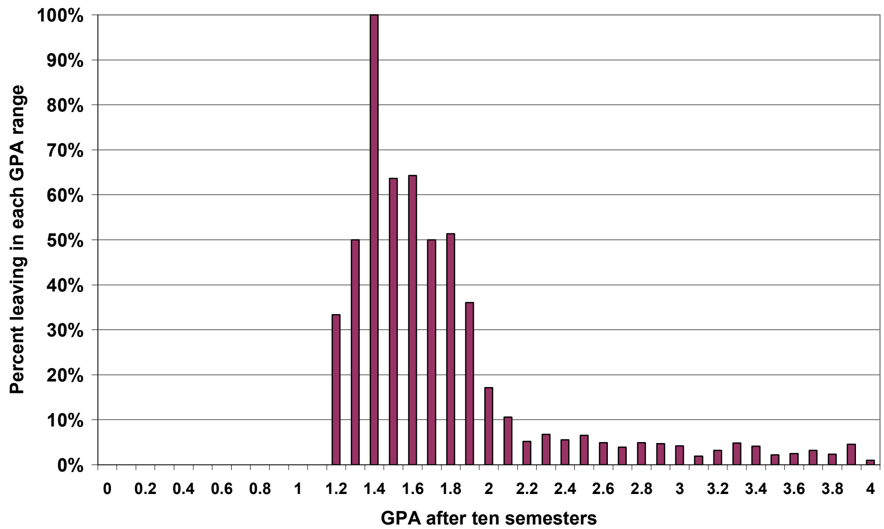

Figure 10. Percent Leaving Engineering of Those in Each GPA Range after Semester 10 (n = 501, N = 8,284)

VII. Conclusions and Future Research

In contrast to the work of Seymour and Hewitt, the results of this study clearly show there were significant academic differences between *stayers* and *leavers* in this very large statistical sample. It is suggested that this is an area that deserves further qualitative study. It is of particular interest to investigate the cause of the attrition of academically well-off engineering students in the early semesters of their degree program, as this group was a significant population. The better performing students who leave in later semesters is a small population and may be dominated by a non-academic baseline attrition factor. If, as we conclude, only 5 to 15% of all matriculated engineering students with a GPA over 3.0 leave engineering yet might be retained by intervention, it seems that retention in this group will not be improved easily. The ceiling for engineering retention might be raised if students were better informed about engineering prior to matriculation. This might be accomplished through high-school curriculum or by pre-college outreach programs.

It is also clear from this study that most of the students who leave engineering because of low GPA do so in the first 3 semesters. Understanding which courses are responsible for the low GPA, correlation with initial placement in math and science courses, impact of course load, and advising or student responses to a poor term are all interesting issues. The partial normal distribution observed around the 2.0 bin in latter semesters suggests that a group of <2.0 GPA students are being permitted continued enrollment with an apparent expectation of graduation. Further research on students who are "unskilled and unaware of it" is of interest for academic advising and policymaking. These students are performing poorly, yet seem persistent nonetheless.

We will follow up on the implications on the treatment of GPA as a continuous variable in studies of first semester students. It is important to understand how this data element should be treated, since it is commonly used in educational studies.

Our work in the area will continue with applying statistical tests of certain of our proposals contained in this paper. With such a large dataset, we typically find that any effect that can be observed with the eye is statistically significant. In most cases involving this database, in fact, the ability to observe the difference with the eye is more demanding than a statistical test. Particularly, we will examine the transition points more closely. In the case of the potential transition point at a GPA of 3.0, we expect to separate populations affected by state-sponsored scholarships from the unaffected population to see if there is a difference.

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