# Predicting Engineering Student Retention

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**Abstract**
Recent retention studies identify factors that exist beyond academic environment as the most critical for student withdrawal. This paper reviews the methodologies and findings of a cluster of studies on retention at NJIT, an urban, public university with large undergraduate and graduate engineering programs. The paper analyzed and compared the outcomes of the students who were successfully enrolled and those who dropped out from NJIT over the period of four years from 1999 to 2003 with the goal to identify early predictors of student success and failure. The study found that a certain combination of high school ranking, pre-calculus placement test results, cumulative grade point average complemented by student level of commitment, as defined by the Entering Student Survey are the best quantitative predictors for the first-year retention.

**Literature Review**
Tinto's (1987) student retention model claims that there are individual reasons for student departure which are affected by a number of interactions within the institutional structure of the college. The individual reasons of student departure include intention and commitment. Students who persist tend to have clear career goals when entering. They intend to pursue their field at this particular college and to graduate. At the end, the decision to leave college is a personal one, but it occurs within an important social context. The student's social interactions within the college context may make or interrupt the decision to leave. Tinto mentions four relevant factors of the college experience: adjustment, difficulty, incongruence, and isolation (Tinto, 1987, p. 39). Each of these factors may become decisive in student's willingness to continue or drop out. Braxton and Shaw Sullivan (1997) supplemented Tinto's study by the empirical research.

Bean and Metzner (1985) proposed a model of attrition for adult students in which retention decisions may often be beyond the scope of the institution. Non-traditional students in that model are distinguished from their traditional counterparts by their intense academic and vocational orientation to college assignments. This model gives the institution the means to intervene in retention decisions. Bean suggests six types of models, all of which have the potential to help understand the attrition process; each model identifies the interrelationships among the various factors and the relationships between these factors and the dropout decision.

Bean's study was supported by Allen (1999) who examined the relationships among four constructs: (1) student motivation, (2) student background, (3) academic performance, and (4)

persistence. Allen indicates that factors external to the students' college experience are the most important ones, especially for minority students.

A comparative study of Canadian and US colleges conducted by Larose, Robertson, Roy and Legault (1998) found that nonintellectual factors were found were strong indicators of the feelings of competence that enabled students to maintain a positive self-image during transitional periods, deal more effectively with new learning situations, and ultimately increase their chances for academic success in both low-risk populations and high-risk populations.

Grandy (1998) looked at attrition rates of underrepresented minorities in natural science, mathematics, and engineering. Some of the major findings revealed that completing the first two years of coursework successfully gives the student encouragement to complete the last two years; male students appeared to need support more than females did, and finally, even when males and females have the same levels of math and science achievement, females had less ambition to make scientific discoveries and contributions than males did.

**Definitions**
For the purposes of this paper, the *CumGPA* was defined as the last recorded cumulative grade-point average for academic performance at the university. *Commitment* was defined as a scaled response to the Entering Student Survey question, "How committed are you to finishing your degree?"

**Design**
The study is a multiple regression analysis of factors correlating with retention (dependent variable) for a single cohort over time and using survey responses and performance data as independent variables. Students were surveyed at the time of entrance to NJIT. The survey captured data on items relative to student reported experience, feelings and beliefs at the time of entrance. Performance data, including persistence and academic performance, are retrieved from the student information system (SIS) and added to cases in the study file.

**Sample**
The sample includes 460 students who were first-time full-time freshmen (FTFTF) in the fall 1999 semester. This includes all FTFTF students who completed the Enrolling Student Survey *and* who provided the social security number on the survey form, allowing tracking student outcomes (persistence and academic performance) in the Student Information Systems. The total number of FTFTF students in fall 1999 was 658, and the sample therefore represents 70% of the total freshman class. A comparison of the sample to the population of FTFTF students indicates that the sample is very similar to the total 1999 FTFTF cohort.

**Instrument**
The survey instrument was an op-scan, paper and pencil form that included 65 items. Twenty-seven scale items included descriptions of student goals and factors in the enrollment decision. Students were asked to describe their financial situations using two multiple-choice items. The high school average, and student academic plans and aspirations were captured, as were the reported emotional support provided by family and friends regarding the decision to pursue a

degree. Five items related to the student level of commitment to earning a degree and to NJIT specifically. The remaining 12 items asked for demographic information.

**Procedure**
Students were asked to complete the enrolling student survey in freshman seminar courses during the first 2 weeks of the fall 1999 semester. All freshmen seminar faculty distributed and collected the forms during class time within the 2-week period, and these forms were returned by the faculty to the Office of Institutional Research and Planning. Forms were op-scanned into an electronic database.

Once the student file was established, Precalculus placement and SAT scores (verbal and math) were collected from the SIS file and added to each student case. In fall semesters of 2000, 2001 and 2002 student cumulative grade point averages were collected from SIS and added to the student case file as well. In addition, it was determined whether students in the cohort had returned for the fall 2000, 2001 and 2002 semesters. Students were then coded as retained or withdrawn based on presence (retained) or absence (withdrawn) in the subsequent semesters. A total of 77 students were coded as withdrawn in 2000; 106 (cumulative) in 2001 and 129 in 2002; and 383 were coded as retained in 2000, 354 in 2001 and 331 in 2002.

a) Analysis
   The following steps were taken to analyze the data:
   1. All items (64 survey items, excluding only the social security number) and SAT verbal and SAT math scores, placement test scores and cumulative grade point average (CumGPA) were correlated (Pearson correlation) with retention/withdrawal and with each other.
   2. All items that correlated significantly with retention/withdrawal were entered into a stepwise multiple regression analysis.
   3. Items that correlated significantly with items that contributed significantly to the stepwise multiple regression were summarized.

b) Results
Three predictors, cumulative-grade-point-average (CumGPA), Precalculus placement test score and commitment, contributed significantly in a 2-step, step-wise multiple regression multiple R of .30. No other variable contributed significantly to the prediction of retention. This means that if a student has a good CumGPA and is highly motivated to complete the degree requirements, that student is likely to be retained. If the student has a poor CumGPA and is not highly motivated to complete the degree requirements, it is highly probable that the student will withdraw. The same conclusion remains consistent throughout 2001 and 2002.

Table l below shows parameters for the analysis:

**Table 1:  Steps in the Multiple Regression Analysis; Dependent Variable–*retained***

a) Stepwise Selection: Step 1
Variable *CumGPA* Entered: R-Square = .3041

Analysis of Variance

| Source | DF | Sum of Squares | Mean Square | F Value_ | pr>F |
|--------|-----|--------|--------|---------|--------|
| Model | 1 | 19.49071 | 19.49071 | 199.75 | <.0001 |
| Error | 457 | 44.59208 | 0.09758 | | |
| Corrected total | 458 | 64.08279 | | | |

b) Stepwise Selection: Step 2
Variable *commitment* Entered: R-Square = .3139

Analysis of Variance

| Source | DF | Sum of Squares | Mean Square | F Value | pr>F |
|--------|-----|--------|--------|---------|--------|
| Model | 2 | 20.11279 | 10.05640 | 104.29 | <.0001 |
| Error | 456 | 43.97000 | 0.09643 | | |
| Corrected otal | 458 | 64.08279 | | | |

c) Summary of Stepwise Selection

| Step | Variable Entered | Number of Vars In | Partial R-Square | Model R-Square | F Value | Pr > F |
|------|---------|---------|---------|---------|--------|--------|
| 1 | *CumGPA* | 1 | 0.3041 | 0.3041 | 199.75 | <.0001 |
| 2 | commitment | 2 | | | | |

## Results: CumGPA and Withdrawals

The mean CumGPA for withdrawn students was 1.54 in 2000, 1.61 in 2001 and 1.86 in 2002 and the mean CumGPA for retained students was 2.84 in 2000, 2.86 in 2001 and 2.93 in 2002.

Figure 1 shows the distribution of the CumGPA for retained and withdrawn students in 2000; Figure 2 -- in 2001 and Figure 3 -- in 2002.

## Figure 1: Distribution of CumGPA scores for retained and withdrawn students in 2000
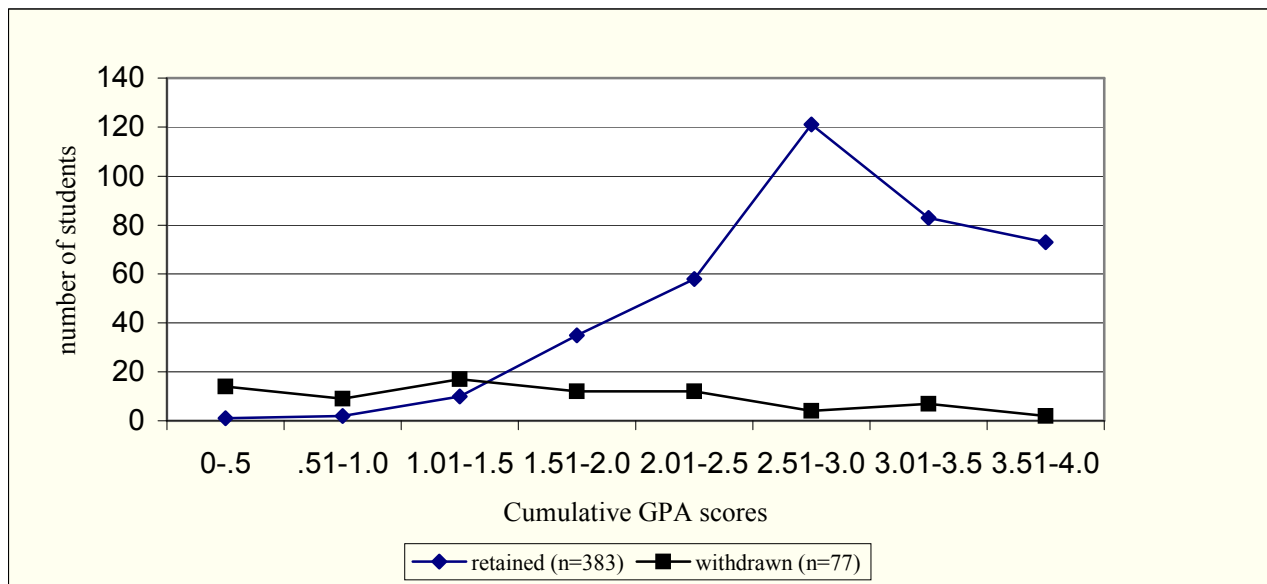
**Figure 2: Distribution of CumGPA scores for retained and withdrawn students in 2001**
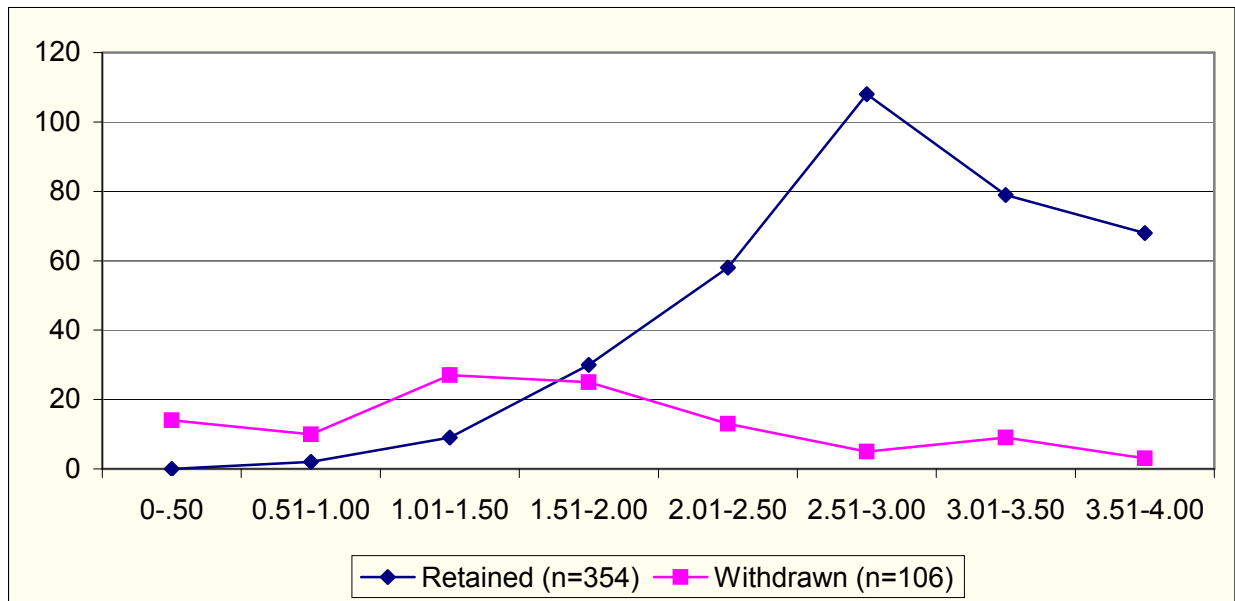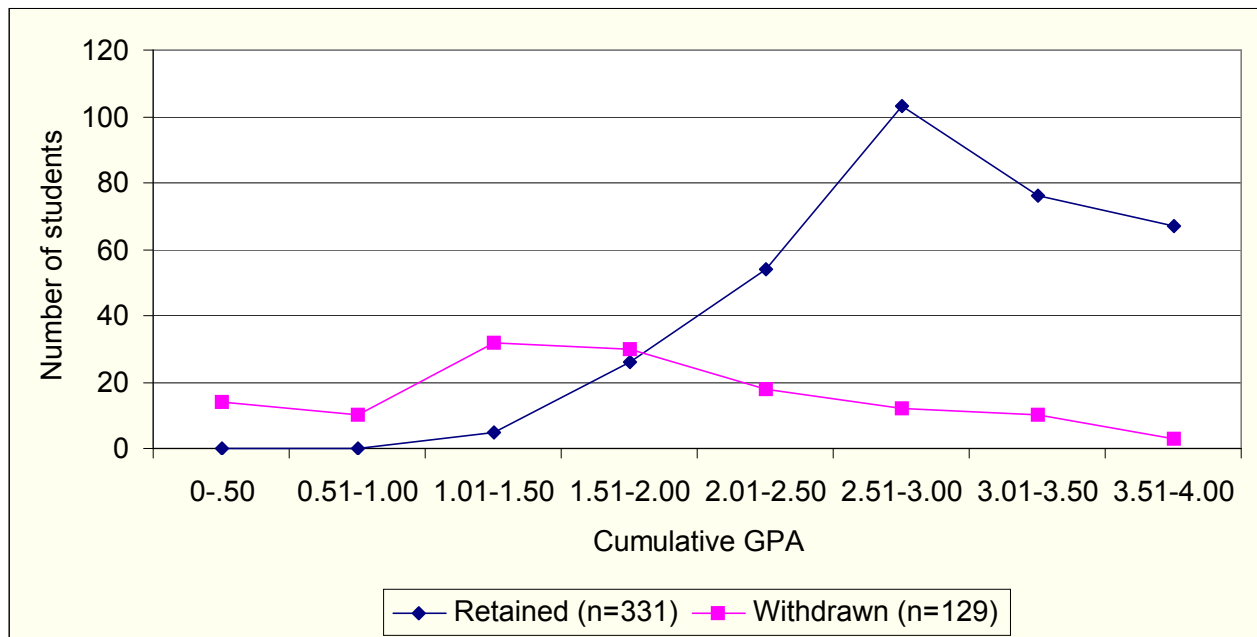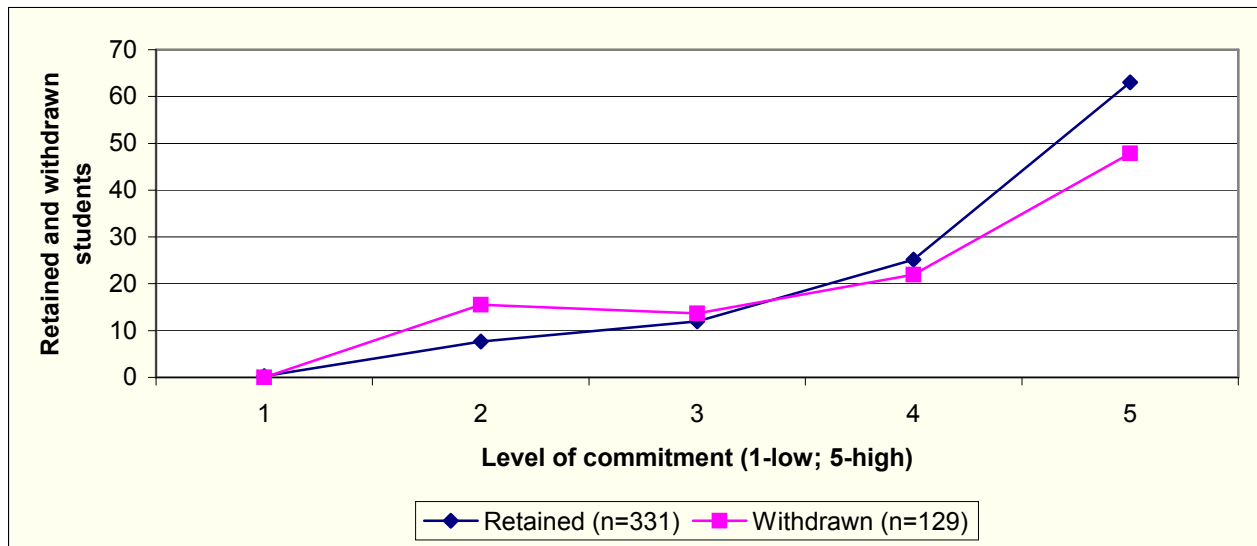


**Figure 3: Distribution of CumGPA scores for retained and withdrawn students in 2002**



**Results: CumGPA and Commitment**

The mean scale score for withdrawn students is 4.03 and the mean scale score for retained students is 4.45 (Figure 4).

**Figure 4: Percent of retained and withdrawn students and reported level of commitment**



**Variables that correlate with predictors of retention/withdrawal**
A Pearson correlation was used to test for variables that correlate with predictors of retention, and results are shown on tables 2 and 3.

**Table 2: Variables that correlate with CumGPA**

| Variable | Pearson correlation coefficient | sign.<.05 |
|---|---|---|
| High school average | .35 | <.0001 |
| Amount of working planned | -.17 | .0002 |
| SAT Math score | .15 | .001 |
| Commitment | .15 | .001 |
| Extent of need for financial aid | .12 | .01 |

**Table 3: Variables that Correlate with *Commitment***

| Variable | Pearson correlation coefficient | sign.<.05 |
|---|---|---|
| Cumgpa | .15 | .001 |
| High school average | .13 | .004 |
| Extent of need for financial aid | .10 | .03 |

Analyses showed that Pre-calculus placement scores are valid predictors of the cumulative GPA, retention rate and graduation rate.  This finding supports the validity of the placement tests as indicators of student academic performance.   Correlations are shown in Table 6.

Table 4: Correlations between Placement Test Scores, Cumulative GPA and Academic Performance Indicators

| Placement Test Score | Cum. GPA | Retention Rate |
|---|---|---|
| Pre-calculus | 0.302 (p<.0001) | 0.490 (p=.005) |

**Implications of the Retention Study**
It is obvious that to get students with the best probability of being retained, students should be selected who have the highest likelihood of succeeding academically, and who are highly committed to completing the degree.   The evidence of this study converges on a profile of the successful NJIT student that includes solid high school and freshman year academic achievement, including math ability, and high motivation, unconstrained by a burden of intense financial need, or the need to work many hours during the school semester.

While the cumulative grade point average that will be earned by the student is not apparent at recruitment, several factors known at recruitment correlate significantly with cumulative grade point average earned during the freshman year.  These include, in order of importance, high school average, amount of time the student will work outside of school, math SAT score, level of commitment to complete the degree, and level of need for financial support.  The student with the higher high school average, prepared to work less at a job outside of school, a high SAT math score, a high level of commitment to completing the degree, and with contained financial need, will perform better academically.

In addition, the extent to which the student is committed to completing the degree contributes meaningful information about the likelihood that the student will persist.  Factors that correlate significantly with level of commitment include the cumulative grade point average, the high school average, and the extent of need for financial aid.  A high level of commitment probably is accompanied by a higher high school average, a moderate amount of need for financial aid, and the probability that the cumulative grade point average to be earned will be higher.

There are numerous aspects of university instruction and support for students that may be influenced by these results.  Because of the importance of student academic performance to student persistence, instructional strategies that most effectively allow students to succeed need to continue to be identified and should be broadly adopted.  Given the importance of math performance (as demonstrated in the contribution of the math SAT score to academic performance), this may be especially true for the delivery of math instruction.

It may be useful to use the freshman seminar as an opportunity to develop the theme of the need for motivation, and the ultimate and considerable benefits to the student of persisting and graduating, in a very focused way.  It may be useful, for instance, to share the results of this

study with freshmen so that they may see the evidence of the importance not only of commitment in general, but the need, in most cases, to limit the amount of time spent working at a job outside school.

Advisement practices need to occur within a framework of allowing the student the best opportunity to succeed. This study suggests, for instance, that math may be an important precursor to academic success at NJIT, and that it should be scheduled early and should be carefully sequenced to optimize success in subsequent courses.

The availability and effectiveness of tutorial support should be further developed to ensure that students who are academically at risk have access to support and that barriers to obtaining tutorial assistance are minimized.

The financial aid program should identify and relieve, whenever possible, those students for whom financial assistance would effectively relieve the need to work excessive hours, especially if prior academic performance indicates that the student is motivated and able to do good quality academic work.

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