A Study of Factors Contributing to Low Retention Rates

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Introduction

Undergraduate engineering programs across the country suffer from declining enrollments due in part to retention problems. College administrators and faculty report that the recruitment and retention of this population has become more difficult[1,2,3,4]. This is especially critical at this time because the number of students graduating from American high schools began to dramatically decline after reaching a peak in 1979[4,5]. Additionally, while colleges and universities are experiencing declining applicant pools and increasing attrition, less money is available to fund institutions of higher education[6].

In order to ensure the continued viability of our engineering programs, we must determine the underlying causes for their poor retention rates. The University of Missouri Rolla (UMR) administration, hypothesizing that low grades affect student satisfaction and subsequent decisions to leave the University, has asked Departments to analyze courses with high levels of low student grades. This paper describes work ongoing at UMR in its Civil Engineering Department that examines several possible factors thought to be associated with student success (and ultimately retention) or lack thereof.

Rationale and Significance

Attrition rates at UMR during the nineties ranged from 10% to 50%[7], which is consistent with figures reported by a number of other colleges and universities[1,2,7,8]. Most students who depart will leave during their first two years. Again, this is consistent with other national studies showing that approximately 75% of the students leave during their first two years. These departures have serious consequences for students. They also present a harsh financial reality for many institutions that rely heavily on tuition revenue to support academic programs, manage physical plants, and deliver student services[1,2].

While many administrators and faculty members report that the students who enroll at their colleges are not as academically prepared as the students who enrolled in the past[3], nearly 85% of student departures are voluntary and occur even though most students maintain adequate levels of academic performance[1]. A subsequent study found that one reason that freshmen remain is their academic preparedness: when students are well prepared, they tend to remain enrolled[9]. Since the number of students departing before graduation exceeds the number who remain, administrators and faculty must develop a better understanding of the students who withdraw and the reasons why they do so[1,2].

The problems associated with retention are not new. A tremendous amount of scholarly activity has been dedicated to the study of student persistence and success. This previous research has considered how demographic factors such as age, gender, race and ethnicity, and socioeconomic background affect retention. Additional studies have focused on how academic factors, including high school grades, college admissions test scores, and college grades, affect persistence and withdrawal. However, based upon the Braunstein study (1997) of administrator and faculty beliefs about reasons for retention, most did not discuss academic factors with respect to retention. Other research efforts have analyzed how financial factors and social factors, such as integration into the academic community and the importance of family and institutional support, affect retention as well[10].

From this brief overview, several conclusions may be drawn:

1. There definitely exists a retention problem
2. Previous research on retention has focused on programmatic characteristics and institutional policies.
3. Today's students are less well prepared than in years past (while engineering curricula have necessarily become even more demanding), yet when well prepared tend to remain enrolled.

In light of these conclusions, this study has as its focus the classroom. Its objective is to examine student performance as it relates to student satisfaction variables, faculty grading policies, faculty communication skills, and enrollment levels.

Experimental Design

Measures selected for each factor are shown in Table 1. Two hundred and nine civil engineering undergraduate course sections over a three year period (Spring 1997 through Fall 2000) were selected for analysis. For the purposes of this preliminary analysis, three multivariate regressions were conducted using proportions of D grades, F grades and withdrawals as the dependant variables, and using enrollment and student ratings of instructor concern for student, ability to stimulate interest, fairness, ability to communicate, preparedness, and workload as the independent variables.

Data from 207 class sections were used to calibrate four models (one for each of the dependent variables described below).

Table 1. Model Variables

PD, PF, PW or PDFW	percent of enrolled students receiving D grades, F grades, withdrawing, and total of all three, respectively
CON	student perception of instructor's concern for students
PRE	student perception of instructor's preparedness
COM	student perception of instructor's ability to communicate
STI	student perception of instructor's to stimulate interest in class content

FAI	average of student perceptions of instructor's grading policy fairness and fairness of exams
HW	student perception of homework length and difficulty
ENR	section enrollment

Discussion of Results

A stepwise regression was used to generate 80 different models from which the four described in Table 3 were selected. The models were chosen based upon:

- signs of their beta coefficients. For example, for enrollment to be included in a model, one would expect for its coefficient to have a positive sign.
- t, significance from zero of the coefficients
- F, measure of the overall significance of the model
- R^2, measure of goodness of fit
- Correlation among independent variables.

With regard to the last item, as Table 2 shows, all of the student evaluation variables are highly correlated. Thus, when choosing among variables, while always trying to eliminate those that do not belong, it was critically important to include those that do - the former due to collinearity concerns and the latter due to concerns about the assumption of independance of error terms. The consequences of not including a variable that belongs in the model and that is highly correlated with an included independent variable are catastrophic on the model's statistics. This observation was borne out in determining the four models in Table 3. For example, the PRE variable is included even though its coefficient is counterintuitive (one would expect instructor preparedness to be negatively correlated with student performance) and it is highly correlated with COM, STI and FAI. When PRE was removed, model statistics, in all instances, degraded significantly. Further, the PRE variable coefficient was positive in all of the 50 or so models in which it appeared. For these reasons, it was included in all of the chosen models.

Table 2. Correlation Matrix

	%D	*%F*	*%W*	*%DFW*	*ENR*	*CON*	*PRE*	*COM*	*STI*	*HW*	*FAI*
%D	1.00										
%F	0.30	1.00									
%W	0.01	0.28	1.00								
%DFW	0.73	0.63	0.64	1.00							
ENR	0.28	0.21	0.05	0.27	1.00						
CON	-0.20	-0.13	-0.10	-0.21	-0.12	1.00					
PRE	-0.12	-0.06	-0.10	-0.14	-0.16	0.77	1.00				
COM	-0.21	-0.09	-0.16	-0.24	-0.08	0.81	0.82	1.00			
STI	-0.18	-0.17	-0.14	-0.24	-0.12	0.87	0.82	0.91	1.00		
HW	-0.04	-0.14	-0.17	-0.16	0.06	0.64	0.66	0.69	0.65	1.00	
FAI	-0.24	-0.22	-0.25	-0.35	-0.11	0.83	0.76	0.80	0.81	0.74	1.00

As Table 3 shows, enrollment, instructor preparation and perceived fairness of the instructor all appear in all models. All are significant, statistically. All variables, excepting PRE, are consistent with intuition. As enrollment increases, DFWs increase, as fairness increases, DFWs decrease (especially the withdrawals, as expected).

Table 3. Final Models

% D grades			% F grades			% Withdrawals			%DFW		
Variable	*β*	*t*	*Variable*	*β*	*t*	*Variable*	*β*	*t*	*Variable*	*β*	*t*
Const.	4.98	1.96	Const.	1.38	0.75	Const.	2.94	2.2	Const.	11.98	2.01
ENR	0.13	2.17	ENR	0.07	2.92	ENR	0.04	1.96	ENR	0.3	3.63
PRE	4.26	2.07	PRE	1.92	2.34	PRE	1.26	2.04	PRE	9.63	3.37
COM	-4.19	-2.09	STI	-1.17	-1.54	FAI	-1.5	-3.47	COM	-5.23	-1.81
HW	3.06	1.57	FAI	-1.91	-1.87				FAI	-9.79	-2.84
FAI	-4.75	-1.72									
$R^2 = 0.18$, $F = 3.60$			$R^2 = 0.20$, $F = 5.23$			$R^2 = 0.17$, $F = 5.23$			$R^2 = 0.30$, $F = 8.77$		

The observed R^2 levels are consistent with models dealing with human behavior. They are not, however, meant to be predictive but rather allow an examination of these class-level variables as they relate to student performance. The models support what has always been assumed, namely, that enrollment, instructor preparation and student perceptions of fairness all play a role in student success. Surprisingly, an instructor's ability to communicate shows only weak significance in the DFW model, and does not even appear in the F and W models. Similarly, the instructor's ability to stimulate interest in course content does not seem to be a strong predictor of student success, nor does the student's perception of workload (the HW variable).

Conclusions

This paper has examined student performance as it relates to student satisfaction variables, faculty grading policies, faculty communication skills, and enrollment levels using data that are readily available at all Universities. The following conclusions may be drawn from the above analysis:

1. Use the more general DFW model when performing analyses such as those described here. The aggregate nature of the data (thus introducing an inherent imprecision), and the much superior statistics of the DFW model suggest this.

2. Enrollment, student perceptions of fairness and instructor preparedness all are significant indicators of student performance at this level of aggregation.

3. Instructor's communication skills, his/her ability to stimulate interest in the course and student perception of workload, all show insignificant statistics.

The use of models such as the ones described in this paper, although useful in examining relationships among classroom variables and student performance are very limited in their usefulness as decisionmaking tools. They are based upon aggregate data and they do not directly address the central issue of retention. Future research in this area should focus on revealed preference, decision-based models, common in econometrics and marketing research, that could directly relate classroom (and other University characteristics) to the individual student's decision to stay or leave.

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