Is High School Performance and Standardized Test Scores as Admission Criteria Enough Considering the Institutional Cost of Misclassification?

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High school performance and aptitude test scores have been shown to have a marginal relationship with common measures of undergraduate student academic success. This minor relationship suggests a source of admission errors which could contribute to tuition revenue loss. This study's objective was to answer the following questions: (1) can discriminant functions be constructed that can correctly classify students as individuals obtaining a degree within a reasonable amount of time or individuals that withdrawal early, (2) how efficient are these discriminant functions, (3) do they differ by gender, and (4) what is the estimated institutional cost of misclassifying students. Results indicated that discriminant functions could be developed that correctly classified approximately 60% of students. These discriminant functions were also shown to have similar success rates for males and females. Finally, the estimated institutional cost of misclassifying students along with error rates of occurrence suggest a source of tuition revenue loss and that improved predictability of student potential for academic retention is needed.

The problem of undergraduate student attrition is an important economic issue due to loss of tuition revenue, cost of recruitment, and government grants tied to institutional performance (Simpson, 2005). This loss of potential revenue coupled with tighter school budgets and expanding pressures to do more with less places increased demand for accurate assessment of incoming students' potential (Murray, 1997). The information primarily utilized to make admission decisions are high school performance and standardized test scores which have been shown to be related to academic success (e.g., Aleamoni & Obler, 1978; Eimers & Pike, 1997; Mathiasen, 1984; Mouw & Khanna, 1993; Neely, 1977; Noble & Sawyer, 1987, 1997; Pike, 1991; Stumpf & Stanely, 2002). However, this relationship is marginal at best and usually requires the addition of other variables to improve the predictability of students' success to adequate levels. This minor relationship between high school performance and college success suggests a source of admission errors which could ultimately result in increased attrition rates and corresponding decreases in revenue.

The primary purpose of this study is to use admission data, more specifically high school performance and standardized test scores, to predict college success as defined by the attainment of a degree within a reasonable amount of time and to evaluate the institutional cost of misclassifying students. This study's objective was to answer the following questions: 1) can discriminant functions constructed from high school grade point average, high school rank, and American College Testing scores be developed that can correctly classify students into "Graduated" or "Dropped Out" categories, 2) how efficient are these discriminant functions in correctly classifying students into the two categories, 3) do these discriminant functions differ for male and female students and 4) what is the estimated institutional cost of misclassifying students into the wrong category.

Method

Subjects

Subjects of the study were limited to students who had enrolled at the University of Northern Colorado between the fall semester of 1998 and the fall semester of 2005. Individuals that were enrolled for three or less years and were not enrolled in the fall of 2005 were classified as "DROP" students. While individuals that obtain a degree within six years of matriculation were classified as "GRAD" students. All other individuals were considered in an academic transition state, i.e. each student will eventually either enter the GRAD or DROP category. Therefore, this category of students was not included in the analyses since their true membership has not yet been revealed. Complete data were found for 9,892 undergraduate students with 3,085 students belonging to the GRAD category split between 1,086 male and 1,999 female students. For the DROP category complete data were found for 6,807 students with 2,790 males and 4,017 females.

Procedure

Data were obtained from admission applications and included gender, high school grade point average (GPA), high school rank (RANK), American College Testing composite scores (ACT), years in which they enrolled, and whether or not they received a degree. Students lacking ACT test scores had their Scholastic Aptitude Test (SAT) scores converted into equivalent ACT test scores using the concordance table developed by Dorans, Lyu, Pommerich, and Houston (1997).

Three discriminant analyses were conducted, one for each of the following groups: total group of students, male students, and female students. In each case, quadratic discriminant functions were developed through the DISCRIM procedure of SAS® with priors equal and all individuals were subsequently classified using the Jackknife method into one of the two categories. All discriminant functions were developed using GPA, RANK and ACT test scores as discriminant variables and were considered statistically significant at an alpha level of .05 or less.

Result and Conclusions

An analysis of the data indicated that statistically significant discriminant functions could be developed for Males [$F_{(3, 3872)} = 57.06$, $p < 0.0001$], Females [$F_{(3, 6012)} = 77.18$, $p < 0.0001$], and the Total Group [$F_{(3, 9888)} = 143.66$, $p < 0.0001$].

Total Group of Students

The discriminant function developed using all of the students were able to correctly classify into the appropriate category 2038 of the GRAD students at 66% accuracy and 3528 of the DROP students at 52% accuracy (Table 1). The total probability of misclassifying a student was .41 with subcategory probability error rates of .17 for GRAD students and .24 for DROP students (Table 2).

Male Students

The discriminant function developed for male students correctly classified 679 of the GRAD students at a success rate of 63% and 1589 of the DROP students at a success rate of 57% (Table 1). This function resulted in a total probability of misclassifying a student of .41 with probability error rates of .19 for GRAD students and .22 for DROP students (Table 2).

Female Students

The discriminant function developed for female students correctly classified 1321 of the GRAD students at 66% accuracy and 1993 of the DROP students at only a 50% success rate (Table 2). This function resulted in a total probability of misclassifying a student of .42 with a probability error rate of .17 for students belonging to GRAD category and .25 for those in the DROP category (Table 3).

Estimating Cost of Misclassification

The cost of misclassifying a particular student would depend on the type of admission decision error, the amount of time until that student either dropped out of school or would have obtained a degree, and the classification of the subsequent student that potentially is being displaced, i.e., whether or not the misclassified student displaces the acceptance of another DROP or GRAD student. The assumption of the latter criteria is that there are a finite number of available admission seats and that the acceptance of a particular student displaces one admission seat available to subsequent students.

University of Northern Colorado Case Study

With tuition revenues for the fiscal year of 2004-2005 being approximately $34.6 million for undergraduate students (UNC A, 2007) and a total undergraduate fall enrollment of 11,014 students (UNC B, 2007), the estimated annual tuition revenue per undergraduate student at the University of Northern Colorado was $3,141 (in 2004 dollars). The misclassification of a GRAD student into the DROP category would result in the student not being accepted into the institution despite the fact that that student would have persisted until graduation and consequently there would be a loss of tuition revenue from that student. The amount of this revenue loss would be determined by how long it would have taken that student to graduate. Approximately 86% of the undergraduate students that graduate from the University of Northern Colorado did so within four to five years of enrollment giving an

Table 1. Correct Classification by Discriminant Analysis in Each Group

	GRAD	DROP
Total Group	2038 (66%)	3528 (52%)
Male	679 (63%)	1589 (57%)
Female	1312 (66%)	1993 (50%)

Table 2. Error Rates and Total Probability of Misclassifying Students

	GRAD[a]	DROP[b]	Total[c]
Total Group	.17	.24	.41
Male	.19	.22	.41
Female	.17	.25	.42

[a] Probability of misclassifying GRAD student into DROP
[b] Probability of misclassifying DROP student into GRAD
[c] Total probability of misclassifying a student.

average academic career of 4½ years (UNC C, 2007) and an average loss of revenue to the institution of misclassifying a GRAD student as a DROP student of $14,135 per student (4½ years x $3,141 tuition revenue per year). Consequently, since the misclassified student was not granted acceptance, admission seat displacement issues are not relevant in this scenario and would not contribute to institutional loss.

The misclassification of a DROP student into the GRAD category would result in the student being accepted into the institution despite his or her future withdrawal and consequently the student would pay tuition as long as they were enrolled. However, the student would eventually withdraw preventing payment of future tuition revenues to the institution. The amount of future revenue loss would depend on the classification, i.e., DROP or GRAD, of the student that was displaced from being accepted following the initial admission decision error and the amount of subsequent years that the student would have enrolled had he or she been accepted. If the misclassified student were to displace the acceptance of a DROP student then the institution ultimately would not incur a loss from the misclassification since that student would have displaced the acceptance of another student who would have withdrawn early as well. However, if the misclassified student displaces the acceptance of a GRAD student the loss to the institution would be the amount of future tuition revenue lost once the student withdraws that would have been paid had the GRAD student not been displaced. Approximately 84% of undergraduate students that eventually withdrew from the University of Northern Colorado did so within the first two years following enrollment suggesting an attrition average of 1½ years (UNC C, 2007). Given an academic career length of 4½ years (from above) and an attrition period of 1½ years, the institution on average would lose out on three years of future tuition revenue following the withdraw of a student and an estimated cost of misclassifying a DROP student as a GRAD student would be approximately $9,423 per student (3 years x $3,141 tuition revenue per year) when a GRAD student is being displaced.

Discussion

The results demonstrated that the use of high school performance and college aptitude test scores can be used to develop discriminant functions that correctly classify students as degree receiving or early withdraw individuals. Overall, the discriminant functions were slightly better at correctly classifying students that belonged to the category that receives a degree which on the surface seems optimistic. However, this ability to correctly classify students is only marginally better than guessing in most cases and no better than guessing in one particular case, i.e., female individuals that withdrew early. The total probability of misclassifying students further support that high school performance and college aptitude test scores can be used to classify approximately 60% of students correctly. But once again, these error rates of correctly classifying students are only marginally better than guessing at 50%. Therefore, the percentages of correctly classified students and the rate of errors in classifying those students support the need for other discriminant variables to improve predictability of students' potential for academic success. Such improvement in predictability of students' academic success would be important especially considering that many institutions automatically accept and reject individuals based on composite scores made up of high school performance and aptitude test scores. Finally, the percentage of correctly classified students and error rates of misclassification were essentially the same for male and females along with the total group of students. The similar rate of errors and percentage correctly classified for all three groups suggests that gender is not essential in determining whether a student will eventually graduate or withdraw. However, other demographic or academic information might reveal differences in admission errors between individuals that graduate with individuals that eventually withdrew.

When considering the cost of making an incorrect admission decision the institution would incur the greatest revenue loss following the misclassification of an individual that would have persisted until

graduating as a student that will eventually withdraw before obtaining a degree and subsequently, deny their acceptance. On the other hand, the misclassification of a student that will withdraw as a student that should persist until graduation would result in less revenue loss and in some situations, i.e., when a student that will eventually withdraw is being displaced, would not result in any loss of tuition revenue despite the occurrence of an error in student classification. Unfortunately, the actual classification of the student being displaced cannot be determined since he or she was never accepted and therefore, would prevent the actual amount of revenue loss to be determined following the misclassification of the initial student. Furthermore, when the cost of making an incorrect admission decision is considered along with the corresponding error rates for those decisions, the misclassification of a student that would persist until graduation as a student that will eventually withdraw, which would result in a larger revenue loss, would also have a lower probability of occurring. While, the misclassification of a student that will withdraw as a student that will graduate would have a greater probability of occurring, it would also have a lower financial impact on the institution. This result suggests that despite the greater probability of making an error in misclassifying a student that withdrawals early as a student that persists until graduating, this error would ultimately have less affect on the institution's "bottom line" than the other error of misclassifying a student that persists until graduating as a student that withdrawals early. However, the occurrence of either error in admission decisions would ultimately result in some amount of tuition revenue loss suggesting the need for improved accuracy in classification of students.

Finally, an institution able to adjust enrollment numbers more efficiently will be able to attenuate their loss of tuition revenue due to admission decision errors. For example, institutions routinely accept more individuals than actually enroll to prevent empty admission seats and admission seats left vacant following a student's withdrawal can be filled with new applicants the following term. However, other sources of institutional revenue such as recruitment cost, student fees, state grants based on institutional performance, and auxiliary services would also contribute to the overall loss in revenue regardless of enrollment efforts (Simpson, 2005; Swail, 2004). These other sources of revenue loss suggest that cost of attrition cannot necessarily be totally "recruited away" and that increased accuracy of students' potential can be one source to reduce the cost associated with attrition.

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