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Jason A. Ricks
Pacific University

Brandon B. Fish
Pacific University

Nicholas J. Kelsey
Pacific University

Adam D. Good
Pacific University

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Predicting academic success in optometry school

Abstract

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Results and Discussion: All undergraduate GPA variables and most OAT subsections demonstrated a significant difference between students who failed an optometry course and those who did not. Reading Comprehension OAT, Physics OAT, and the interview score did not demonstrate a statistically significant difference between the two groups. Three equations were developed to help predict GPA in optometry school and to predict the probability of a student failing an optometric course.

Conclusion: The equations discussed can be used by admission committees as one tool to help in the application process and to predict success prior to admitting optometric students.

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Committee Chair

Denise Goodwin

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admission, optometric education, grade point average, academic difficulty, optometry admission test

Subject Categories

Optometry

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PREDICTING ACADEMIC SUCCESS IN OPTOMETRY
SCHOOL

Jason A. Ricks, B.S.
Brandon B. Fish, B.S.
Nicholas J. Kelsey, B.S.
Adam D. Good, B.S.

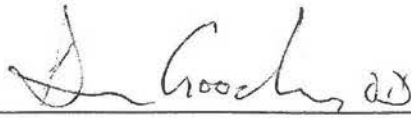
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Advisors:
Denise Goodwin, O.D., F.A.A.O.
Lee Ann Remington, O.D., M.S., F.A.A.O.

Signatures

Faculty Advisors:

Denise Goodwin, O.D., F.A.A.O.

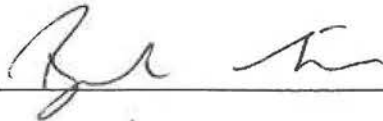


Lee Ann Remington, O.D., M.S., F.A.A.O.

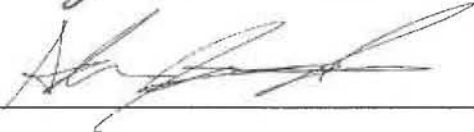


Student Authors:

Brandon B. Fish



Adam D. Good



Nicholas J. Kelsey



Jason A. Ricks



Statistician:

Todd E. Bodner, Ph.D.



Biographies

Brandon B. Fish, B.S.

Brandon B. Fish received a Bachelor of Science degree from Idaho State University with a major in Zoology in 2003. While attending ISU Brandon was on the dean's list, and was awarded with membership in the Golden Key International Honor Society for his academic achievement. He served an LDS mission in Norway for two years from 1997 to 1999. He met his wife while attending Idaho State University and the couple now has two children. After graduation from optometry school Brandon plans to practice in Idaho.

Adam D. Good, B.S.

Adam D. Good graduated with an associate degree from Ricks College (presently Brigham Young University Idaho) and graduated Cum Laude, completing a Bachelors of Science in Biology from Brigham Young University Hawaii. He has been married for five years to his wonderful wife Darlene. Adam and Darlene have been blessed with two energetic daughters. Adam has been active in the Amigos Club and recently served an eye care mission in the Philippines. After graduation, Adam plans to provide eye care in the Pacific Northwest.

Nicholas J. Kelsey, B.S.

Nick Kelsey received a Bachelor of Science degree from Pacific University majoring in Biology. Before attending Pacific University, he attended Idaho State University and the College of Southern Idaho. While attending Idaho State, Nick married Angie Lancaster and they have been happily married for five years. After graduating from optometry school, Nick and Angie plan to practice optometry in the Northwest.

Jason A. Ricks, B.S.

Jason received an Associate of Letters and Science from Ricks College - Rexburg, Idaho in 2000 and a Bachelor of Science in Cell Biology and Neuroscience from Montana State University – Bozeman, Montana in 2002. He was on the Deans List at both universities as he pursued his desire of attending optometry school. He was awarded the rank of Eagle Scout in 1992 and served a two year mission in England between 1997 and 1999. He worked for the U.S. Forest Service for three and a half years researching the lynx habitat in the Pioneer Mountain range. In 2002 he married Britney Hadley and they are now the proud parents of a baby boy named Carter. Jason currently sits as a student member of the admissions committee for the school of optometry. He has been a member of Beta Sigma Kappa Optometric Honor Society since 2004. He plans to return to his native state of Montana to privately practice optometry in a small group practice.

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Key words: *admission, optometric education, grade point average, academic difficulty, Optometry Admission Test*

Introduction

Predicting student success in optometry school is a difficult task. Optometry admission committees have a pool of applicants from which they are responsible for selecting students who are likely to succeed both academically and clinically. In the process, many academic and non-academic qualities are evaluated prior to allowing admission to optometry school. It is challenging for committees to rank each of these characteristics.

For many years there has been a significant decline in the number of optometry school applicants.¹ Because class size cannot change based on the number of applicants, schools may be compelled to accept students that are less likely to be successful with the rigorous optometric curriculum.

At Pacific University College of Optometry (PUCO) there has been an increase in the number of students experiencing academic difficulty. This situation may cause a student to be dismissed or to be placed on a modified curriculum resulting in scheduling difficulties, decreased coherence of learning, and increased expense on the part of the student and college.

No recent studies have examined the relationship between Optometry Admission Test (OAT) scores, undergraduate (UG) grade point average (GPA), and optometry school performance. Older studies have correlated GPA and admission testing with academic success.^{2,3,4} However, these studies were performed at least 10 years ago when many state laws did not even allow optometrists to use therapeutic medications. Since that time the emphasis of optometric education has changed greatly. The number and type of required optometric courses, the emphasis of the National Board of Examiners in

Optometry, student learning styles, and teaching methods have been modified extensively. These changes warrant a more current investigation into the factors that predict academic success in optometry school.

This study was designed to determine which admission factors have the greatest impact on academic success and to develop methods that admission committee members can use to more accurately select the best candidates from the applicant pool. Specifically, the study attempts to predict the GPA at the end of the first year of optometry school, the GPA at the end of the second year of optometry school, and the probability that a student will fail any didactic course during their optometry school education.

Methods

Data were collected for 177 students who were admitted to PUCO during 2001 and 2002. Two students who left school for non-academic reasons were not included in the study leaving 175 records.

Table 1 lists the undergraduate characteristics that were evaluated. The study considered variables that admission committees are likely to consider prior to accepting an applicant. Optometry admission committees rely heavily on undergraduate GPA, OAT scores, a preadmission interview, and letters of recommendation.^{3,5} Due to the difficulty in formulating a standardized score for evaluating letters of recommendation, this variable was not included in the study.

To protect student confidentiality, the Office of the Director of Student Services

removed from the undergraduate and optometry school transcripts all information that could be used to identify individual students. This included name, social security number, and undergraduate institution. Additional undergraduate information, including OAT scores and admission interview scores, were obtained from the Admission Office. The Director of Student Services' office assigned all students a randomized number ensuring that all undergraduate grades, OAT scores, interview scores, and optometry grades correlated correctly.

The OAT is a multiple choice examination designed to test the applicant's academic abilities and comprehension of scientific information. Scores in each individual section range from 200-400. A score of 300 represents an average score.⁶ Subsections of Biology, General Chemistry, Organic Chemistry, and Physics are combined for the Total Science score. Scores from the Total Science subsections are combined with the Quantitative Reasoning and Reading Comprehension scores to obtain an Academic Average.

GPA data was calculated in several different ways including UG cumulative GPA, GPA of all UG science courses, and GPA of the last 45 credits prior to the time of optometry school application. In order to compare United States transcripts with Canadian school transcripts, each Canadian university provided a legend to convert Canadian grades to the equivalent United States format.

The pre-admission interview score is based on a point scale with a maximum award of 100 points. The total interview score is the average score from two interviewers who are usually members of the admission committee. In general, the committee is looking for personality, communication ability, demeanor, intelligence, knowledge of

optometry, and critical thinking skills. A small portion (10 points) of the interview score is based on the quality of an impromptu writing assignment.

GPA after the first year of optometry school, cumulative GPA after the second year of optometry school, cumulative GPA after the third year of optometry school, and the number of didactic courses a student failed, if any, were determined. A grade less than 75% is considered failing in any optometry course at PUCO. Grades that are based solely on clinical performance were not included. Because grades in the fourth year at PUCO are based on clinical performance, this data was not included in the analysis.

Students who failed one or more class (FAILS) were compared with students who successfully passed all optometry school classes on their first attempt (NO FAILS). An unpaired t-test was used to compare parametric characteristics. A *p*-value less than 0.05 was considered statistically significant.

Regression analysis allowed weighting of data in order to determine which combinations of variables had the highest correlation with the outcome measures. By using this type of analysis, we established equations to predict academic performance of an optometry student.

Results

At the time of analysis, all students in this study who had not been dismissed from optometry school had completed their third year of the optometry program. There were 135 students who passed all optometry courses, while forty students failed at least one course during optometry school. Of these forty, twelve students failed two courses, and

ten students failed three or more courses. Six students were dismissed from optometry school for academic reasons including three students who were dismissed after their first year of optometry school and three students who were dismissed after their second year of optometry school.

Group mean differences. Table 1 shows the results of the *t*-tests comparing FAILS and NO FAILS. Group means for UG cumulative GPA, the UG Science GPA, and the GPA of the last 45 credits prior to the time of optometry school application were found to be significantly different between FAILS and NO FAILS. The UG Science GPA shows the greatest difference between the means (0.28) followed by the last 45 credit hours GPA (0.23) and cumulative GPA (0.19).

Six of the eight OAT scores showed significant mean differences between groups. The Reading Comprehension and Physics sections did not show a statistically significant mean difference between the groups. The Overall Academic Average OAT for NO FAILS was 322.44. The FAILS averaged 308.57 for a difference of 13.87. Table 1 lists the means for individual sections of the OAT.

Mean interview scores were not significantly different between the two groups.

Bivariate associations. The correlations among the studied variables are shown in Table 2. All undergraduate GPA values show a strong correlation with the first and second year GPA and failing a course in optometry school; however, UG Science GPA and the GPA of the last 45 credits taken were stronger predictors of GPA and failing a class than the cumulative GPA. All OAT subsections demonstrated a significant correlation with first and second year GPA. Reading Comprehension OAT did not correlate well with whether a person was likely to fail an optometry course. The

interview score did not have a statistically significant correlation with either GPA variables or with whether a person failed an optometric course.

Prediction of first and second year cumulative grades. The magnitude of the correlations among these variables suggest a degree of redundancy in their ability to predict academic success (i.e., passing courses and achieving good GPAs). Thus, the following regression analyses serve to select the variables with the strongest unique abilities to predict these academic successes. The four independent variables shown in Table 3 were the used in regression analysis. These variables were chosen to avoid using interrelated values. The Total Science OAT was used in the statistical analysis because it reflects the scores of Biology, General Chemistry, Organic Chemistry, and Physics. The Reading Comprehension and Quantitative Analysis OATs were included in the statistical analysis because they are not included in the Total Science OAT. Similarly, the UG Cumulative GPA and the UG Science GPA are interrelated. This and other studies^{2,4} found a high correlation between UG Science GPA and GPA after the first and second year (See Table 2); therefore, only the UG Science GPA was used in this analysis.

Regression analysis using the four predictor variables (see Table 3) was preformed in order to predict the cumulative optometry GPA at the end of the first year. The four predictors account for 36.2% of the variance in the cumulative first year GPA ($R^2 = .362, p < .001$). Total Science OAT, Quantitative Reasoning OAT, and the UG Science GPA had significant partial associations with the cumulative first year GPA; however, the partial association for Reading Comprehension OAT was not statistically significant. This result suggests that Reading Comprehension OAT does not add significant predictive utility once the other three predictor variables are included in the

equation.

A second regression analysis was conducted without the Reading Comprehension OAT. The remaining set of predictors accounts for 35.6% of the variance in cumulative first year GPAs ($R^2 = .356, p < .001$). Thus, the final prediction equation for cumulative first year GPA is as follows:

$$\text{Predicted GPA after the first year of optometry school} = -.404 + .004 * (\text{Total Science OAT}) + .003 * (\text{Quantitative Reasoning OAT}) + .490 * (\text{UG Science GPA})$$

Results are similar when using the cumulative GPA at the end of the second year as the outcome variable. The set of four predictors accounts for 33.2% of the variance in the cumulative second year GPA ($R^2 = .332, p < .001$). Reading Comprehension OAT, again, does not add significant predictive utility after the other three predictor variables are included in the equation. After dropping the Reading Comprehension OAT, it was found that the remaining three predictors account for 32.5% of the variance in the cumulative GPA after the second year of optometry school ($R^2 = .325, p < .001$). Each partial regression slope was statistically significant. Thus, the final prediction equation for the cumulative second year GPA is as follows:

$$\text{Predicted GPA after the second year of optometry school} = .700 + .002 * (\text{Total Science OAT}) + .002 * (\text{Quantitative Reasoning OAT}) + .381 * (\text{UG Science GPA})$$

Prediction of course failure. Using the same four predictor variables, logistic regression analysis was performed with failure in any course as the outcome variable. The set of four predictors accounts for 18.7% of the variance in the log-odds of course failure (Nagelkerke $R^2 = .187$, $p < .001$). Because the predictors are correlated, a backward selection logistic regression analysis was conducted to drop non-significant predictors one at a time. The final model has two predictors: Total Science OAT and UG Science GPA. As a set, the two predictor variables significantly predict the log-odds of course failure ($p < .001$) and each individual partial logistic regression coefficient was statistically significant. Descriptively, these two predictors account for 16.9% of the variance in the log-odds of course failure (Nagelkerke $R^2 = .169$, $p < .001$).

Inspection of the classification table for this final model suggests that the model correctly classifies 70% of those who fail any course and correctly classifies 62% of those that do not fail any course. The prediction equation is as follows:

$$\text{Predicted log-odds of failure} = 8.321 - .016 * (\text{Total Science OAT}) - 1.463 * (\text{UG Science GPA})$$

Discussion

Admission committees take into account several factors when assessing an optometry school applicant. Undergraduate GPA and OAT scores are used by admission committees in the selection of candidates. Students who have academic difficulty in undergraduate studies appear to have difficulty with one or more courses in optometry

school.

Emphasis can be placed on specific application data to evaluate optometry applicants and help determine if they have the potential to succeed in the challenging optometric curriculum. The UG Science GPA was found to be a significant predictor of academic success in optometry school. The majority of OAT scores were also found to correlate with didactic abilities. Reading Comprehension OAT, Physics OAT, and the interview score were not found to be significant predictors of whether or not a student will fail a course in optometry school.

Ideally an admission committee would have a concrete formula that could predict success or failure in optometry school. Due to the multiple factors involved in academic success, including both cognitive and non-cognitive factors, it is impossible to predict this with 100% certainty. However, using regression analysis, the likelihood of failing a class in optometry school and the student GPA at the end of each academic year can be estimated based on UG Science GPA and OAT scores. As the results of the regression analyses indicate, this information is useful in selecting applicants for admission who are likely to exhibit acceptable academic progress in the program.

The following example illustrates how to translate the predicted log-odds of failure into a predicted probability of course failure:

Suppose there are three individuals, each with the same Total Science OAT. For illustrative purposes, the sample mean of 323.43 is used. However, these three individuals differ with respect to their UG Science GPA. Person A has an average one standard deviation (SD) below the mean (2.73), Person B has an average at the mean (3.17), and Person C has an average one SD above the mean (3.61). The predicted log-

odds, odds, and probability of course failure for each individual is as follows:

Person A:

$$\begin{aligned} \text{Predicted log-odds} &= 8.321 - .016 * (\text{Total Science OAT}) - 1.463 * (\text{UG Science GPA}) \\ &= 8.321 - .016 * (323.43) - 1.463 * (2.73) = -.84787 \end{aligned}$$

$$\text{Predicted odds} = \exp(-.84787) = .4283$$

$$\text{Predicted probability} = .4283 / (1 + .4283) = .300$$

Person B:

$$\begin{aligned} \text{Predicted log-odds} &= 8.321 - .016 * (\text{Total Science OAT}) - 1.463 * (\text{UG Science GPA}) \\ &= 8.321 - .016 * (323.43) - 1.463 * (3.17) = -1.49159 \end{aligned}$$

$$\text{Predicted odds} = \exp(-1.49159) = .2250$$

$$\text{Predicted probability} = .2250 / (1 + .2250) = .183$$

Person C:

$$\begin{aligned} \text{Predicted log-odds} &= 8.321 - .016 * (\text{Total Science OAT}) - 1.463 * (\text{UG Science GPA}) \\ &= 8.321 - .016 * (323.43) - 1.463 * (3.61) = -2.13531 \end{aligned}$$

$$\text{Predicted odds} = \exp(-2.13531) = .1182$$

$$\text{Predicted probability} = .1182 / (1 + .1182) = .106$$

As this example illustrates, for individuals at the mean Total Science OAT, a person with an UG Science GPA 1 SD below the mean has almost three times the predicted probability of failure in any course compared to a person with an UG Science GPA 1 SD above the mean.

Using various Total Science OAT and UG Science GPA values, a table was constructed to link predicted log-odds admission scores to predicted probabilities (see Table 4). Note that that lower admission scores correspond with lower predicted probability of failing at least one course. This table may be used by admission committees to help predict success in optometry school. For example, if you want the probability of course failure to be less than .50, the needed admission score would need to be below .011. For a probability of course failure less than .23 (i.e., the failure base rate in this sample), an applicant would need an admission scores less than -1.2. To illustrate this latter situation, consider that a student scoring better than 315 on the Total

Science OAT with an UG Science GPA better than 3.06 would have an admissions score less than -1.2. Of course poorer Total Science OAT scores could be offset by better UG Science GPA to achieve an admissions score less than -1.2.

No recent studies have evaluated the relationship between OAT scores, undergraduate GPA, and optometry school performance for incoming optometry applicants. However, older studies have found similar results. Corlis⁴ designed a study in 1991 to help admission committees predict first year optometry GPA. He found that UG Science GPA, variability in UG cumulative GPA, and Optometry College Admission Test (OCAT) Average had the highest correlation with first year optometry GPA. In 1997, Kramer and Johnston² evaluated 534 students from seven optometry schools. Similar to the current study, this analysis found that the Total Science OAT showed the strongest correlation with the first year optometry GPA. The next highest correlations were Academic Average OAT and UG science GPA. Results were similar for the second year GPA.

In contrast, Wingert et al³ found very different results. This study found that the best predictors of performance in the first year of optometry school were the UG cumulative GPA in combination with the score on the OCAT Reading Test and the personal interview. In that same study, the most significant predictor of the second year GPA was found to be the interview score, the OCAT biology subtest, and the UG Science GPA. This contrasts with our current results which demonstrate that the interview score was of little value in predicting first or second year GPA. We also demonstrated that Reading Comprehension OAT has minimal effect on predicting optometry GPA and did not demonstrate statistical difference between students who fail a class in optometry

school and students who pass all optometry classes. Variation and subjectivity in scoring the interview may play a role in the differences between the two studies. Significant changes in the optometry curriculum, admission testing, student learning styles, and teaching methods may also account for this disparity. Given the immense changes that have occurred since other studies have taken place, the updated results of the current study will be extremely useful to admission committees in deciding whether an applicant will likely succeed in optometry school.

Limitations. Due to confidentiality issues, our study did not take into account the competitiveness of the undergraduate institution. This value has been shown to aid in predicting academic success⁴ and can be found in sources such as Barron's Profile of American Colleges.⁷ Competitiveness can be determined by preadmission variables such as ACT and SAT scores and the applicant to acceptance ratio.

Data on students with very low GPA or OAT scores are not available for analysis because these students are not admitted. This selection process may influence the statistical relationship.

The fact that 70% of FAILS were correctly classified is good. However, the fact that 38% of NO FAILS were classified as failing a course suggests that some caution is needed in using the logistic prediction equation for admission purposes. Future studies could explore other academic and non academic variables, including letters of recommendation, that might increase the prediction accuracy both in terms of the sensitivity (i.e., correctly identifying students likely to fail a course as FAILS) and specificity (i.e., correctly *not* identifying students unlikely to fail a course as FAILS) of the prediction equation.

Success in optometry school is dependant on both cognitive and non-cognitive aspects. Although the non-cognitive aspects might help determine student success in optometry school, this study was designed to focus primarily on cognitive characteristics. It is also important to note that this study attempts to predict academic success. The results do not necessarily correlate with clinical performance or success in an optometric practice situation. Future studies are necessary to evaluate which characteristics predict success in a clinical setting.

Conclusion

There is no single predictor to determine success in optometry school. The models generated by regression analysis can decrease time spent on the decision process by decreasing the number of variables and by creating a standardized tool that can be applied to all applicants. Predicting success before admitting students can decrease expense, frustration, and wasted time on the part of the students as well as optometric faculty and administration.

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| Category | Status | Mean | Significance |
|--------------------------------------|----------|--------|--------------|
| Undergraduate Science GPA | No Fails | 3.2388 | .0002* |
| | Fails | 2.9560 | |
| GPA of last 45 undergraduate credits | No Fails | 3.5024 | .0003* |
| | Fails | 3.2748 | |
| Cumulative undergraduate GPA | No Fails | 3.3431 | .0023* |
| | Fails | 3.1540 | |
| Overall OAT | No Fails | 322.44 | .0003* |
| | Fails | 306.00 | |
| Quantitative reasoning OAT | No Fails | 312.37 | .0037* |
| | Fails | 293.00 | |
| Reading OAT | No Fails | 333.19 | .1294 |
| | Fails | 323.00 | |
| Physics OAT | No Fails | 313.85 | .0522 |
| | Fails | 300.00 | |
| Biology OAT | No Fails | 324.00 | .0174* |
| | Fails | 305.25 | |
| General Chemistry OAT | No Fails | 323.04 | .0027* |
| | Fails | 311.00 | |
| Organic Chemistry OAT | No Fails | 322.74 | .0019* |
| | Fails | 299.00 | |
| Total science OAT | No Fails | 327.93 | .0013* |
| | Fails | 308.25 | |
| Interview Score | No Fails | 78.888 | .1360 |
| | Fails | 75.458 | |

Table 1: The mean and statistical significance level of undergraduate characteristics that were evaluated. Statistically significant variables are marked with an asterisk.

| Variable | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) |
|--------------------------------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|------|
| (1) FAILS | 1 | | | | | | | | | | | | | | |
| (2) GPA1 | -.686* | 1 | | | | | | | | | | | | | |
| (3) GPA2 | -.679* | .966* | 1 | | | | | | | | | | | | |
| (4) UG Science GPA | -.273* | .489* | .478* | 1 | | | | | | | | | | | |
| (5) Last 45 Credits GPA | -.282* | .486* | .483* | .698* | 1 | | | | | | | | | | |
| (6) Cumulative GPA | -.222* | .430* | .427* | .926* | .697* | 1 | | | | | | | | | |
| (7) Academic Average OAT | -.274* | .459* | .430* | .279* | .290* | .202* | 1 | | | | | | | | |
| (8) Quantitative Reasoning OAT | -.226* | .372* | .363* | .227* | .195* | .166* | .665* | 1 | | | | | | | |
| (9) Reading Comp OAT | -.110 | .249* | .248* | .122 | .115 | .117 | .534* | .367* | 1 | | | | | | |
| (10) Physics OAT | -.158* | .316* | .267* | .206* | .253* | .131 | .791* | .477* | .226* | 1 | | | | | |
| (11) Biology OAT | -.206* | .351* | .306* | .240* | .219* | .165* | .773* | .320* | .332* | .567* | 1 | | | | |
| (12) General Chemistry OAT | -.192* | .389* | .330* | .213* | .276* | .131 | .734* | .367* | .207* | .621* | .567* | 1 | | | |
| (13) Organic Chemistry OAT | -.241* | .287* | .293* | .177* | .188* | .160* | .645* | .268* | .093 | .437* | .427* | .471* | 1 | | |
| (14) Total Science OAT | -.244* | .411* | .368* | .243* | .276* | .165* | .916* | .436* | .258* | .830* | .807* | .805* | .713* | 1 | |
| (15) Interview | -.182 | .099 | .131 | -.099 | .012 | -.103 | .020 | .001 | .038 | -.040 | .023 | -.012 | .033 | .004 | 1 |

Table 2: The correlation values for variables used to compare success in optometry courses. Notes: FAILS = Failure for any course; GPA1 = cumulative GPA at end of first year; GPA2 = cumulative GPA at end of second year; UG = Undergraduate. N for all statistics equals 175 except for those involving GPA2 where N = 172. Correlations significant at $\alpha = .05$ level are marked with an asterisk.

| |
|---|
| Total Science OAT score Quantitative Reasoning OAT score Reading Comprehension OAT score Undergraduate Science GPA |
|---|

Table 3: Data used in regression analysis.

| Admissions Score | Predicted Probability |
|------------------|-----------------------|
| -3.931 | .02 |
| -3.628 | .03 |
| -3.324 | .03 |
| -3.021 | .05 |
| -2.718 | .06 |
| -2.415 | .08 |
| -2.111 | .11 |
| -1.808 | .14 |
| -1.505 | .18 |
| -1.202 | .23 |
| -0.898 | .29 |
| -0.595 | .36 |
| -0.292 | .43 |
| 0.011 | .50 |
| 0.315 | .58 |
| 0.618 | .65 |
| 0.921 | .72 |
| 1.224 | .77 |
| 1.528 | .82 |
| 1.831 | .86 |

Table 4: Predicted probabilities of at least one optometry course failure given particular Admission Scores. The Admissions Score is based on the equation $8.321 - .016 * (\text{Total Science OAT}) - 1.463 * (\text{UG Science GPA})$.