

Predicting Successful Completion of the Nursing Program:

An Analysis of Prerequisites and Demographic Variables



Introduction

In the summer of 2002, a research study commissioned by the Center for Student Success examined predictors of successful completion of 20 community college Associate Degree Nursing (ADN) programs across the state of California (see Phillips, Spurling and Armstrong 2002). That study generated considerable publicity because of its findings that over a five-year period, academic measures of success like core biology GPA, overall college GPA, and core science repetitions were very accurate predictors of successful completion of a program within three years (Phillips, Spurling and Armstrong 2002, 29-31). The study also sparked some controversy because of its findings that academic prerequisites had a powerful ability to predict subsequent academic success, and that “cut scores” based on the findings could be used to establish a competitive admissions process that would likely shut out a larger proportion of minority students (Phillips, Spurling and Armstrong 2002, 36). In some circles of higher

*Matt Wetstein, Interim Dean
Planning, Research, and Grants Development
San Joaquin Delta College*

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education the study got a lukewarm reception, precisely because it challenged the notion of open access to the academic and vocational programs of the community college system.

In late 2002, the Office of Planning, Research, and Grants Development was approached by the Dean of Vocational Education and Economic Development to see if the 2002 study could be replicated at Delta College, and to examine the impact of various variables on the success of students in the College's ADN program. For several weeks, office staff collaborated with staff and the Nursing Program Director to collect data on recent participants in the College's ADN program. The study was completed with the collaborative assistance of Debra Lewis, Assistant Division Chair, Irene Cotta, Secretary, Paula Bennett, Confidential Secretary, Francisco Mora, Research Analyst, and was directed by Matt Wetstein, Interim Dean of Planning, Research, and Grants Development.

Data and Methods

Data for this study are drawn from two sources: the electronic records of student course completion in the College's proprietary data base (System 2000), and application records maintained by the Office of Health Sciences in the Family, Consumer and Health Sciences division. The data are drawn from the student population who enrolled in the Nursing 1 course during the 1997-1999 period. This time frame allowed for the collection of data over a three-year period to "track" student success. Successful completion was noted if a student was able to complete the curriculum and receive a nursing degree within a three-year span, so students enrolling in 1997 were tracked through 2000, while students enrolling in 1999 were tracked through 2002. This variable (successful completion within three years) paralleled the criteria established in the earlier study by Phillips, Spurling and Armstrong (2002). It served as the

dichotomous dependent variable of interest (1 = successful completion, 0 = unsuccessful completion).

A host of independent variables were collected for each student. They included ethnicity, gender, age, English speaking abilities (native versus non-native speakers), grades in science prerequisite courses, grades in nutrition prerequisite courses, grades in English 1A (a prerequisite instituted in 1998), and the number of science course repetitions for each student. Prior research had identified the GPA and course repetition variables as statistically significant predictors of program completion. Age, ethnicity, gender, and English speaking patterns were included in the analysis to test for their impact in the face of controls for overt measures of academic performance.

The analysis focused on 223 students for which there was complete data. Students were excluded if we were unable to provide precise accounting for any of the prerequisite grade measures. This led to the exclusion of 35 students from the initial sample of Nursing 1 enrollments in the 1997-99 period. The general approach to the study was to examine the successful completion of a student and construct a multivariate regression model using independent variables to predict successful program completion. The final regression model utilized in the study took on the form of a logistic regression equation positing a relationship in the following form:

$$\begin{aligned} \text{Predicted probability of} &= a + b1 (\text{Age at program entry}) + \\ \text{successful completion} & \quad b2 (\text{Cumulative GPA}) + \\ & \quad b3 (\text{Science prerequisite GPA}) + \\ & \quad b4 (\text{Science course repetitions}) + \\ & \quad \text{error term (unexplained variance)} \end{aligned}$$

Results

Table 1 provides mean values for the variables in the study, along with the mean value for successful completion of the ADN program at Delta College for students enrolling between 1997 and 1999. Since the success measure is a dichotomous score of 0 or 1, the mean value of .78 found in Table 1 suggests a 78 percent completion rate within three years of program entry. This compares favorably with the statewide study, which found a 79 percent overall completion rate within three years (Phillips, Spurling and Armstrong 2002, 30). The data also reflect a preponderance of female students, and a roughly even split between white students and students of other ethnic backgrounds. The average age of the students at program entry was 30 years of age, with students as young as 19, and as old as 55 in the sample studied.

Table 1
Mean Values for Variables in the Study

Variable	Range of Scores	Mean
Gender	0 = male, 1 = female	.848
White/Non-white	0 = non-white, 1 = white	.556
Native English Speaker	0 = no, 1 = yes	.892
Age	19 to 55	30.058
Science repetitions	0 to 8	.574
Science prerequisite GPA	1.60 to 4.00	2.940
Cumulative GPA	1.36 to 4.00	3.058
Success	0 = no, 1 = yes	.780

The maximum likelihood estimates from the logistic regression equation were generated in a program titled Statistical Package for the Social Sciences (SPSS), and can be found in Table 2. Age was the only demographic variable included in the model because the other variables proved to be insignificant predictors of program completion when controlling for academic factors. Logistic coefficients are not readily interpreted in their raw form, partly because the model does not imply a direct linear relationship found in most social science techniques.

Instead, the equation is fitted to a curvilinear function that takes on the shape of an “S” curve, altering the slope of the relationship as one moves along the hypothesized range of the dependent variable (in this case 0 and 1, see Aldrich and Nelson 1984). The coefficients must be transformed using a logistic function to calculate the probability of an outcome, based on a specified level of an independent variable. These transformations are accomplished in Tables 3 through 6, but Table 2 does allow for an inspection of the statistically significant relationships between successful completion and independent variables.¹

Perhaps the most significant variable in the study for predicting successful completion is science prerequisite GPA ($b = .74, p = .02$). The absence of a negative sign suggests an overall positive relationship between core science GPA and successful nursing program completion. Surprisingly, age was statistically significant as well, with a negative relationship suggested between student age and program completion ($b = -.05, p = .01$). On further reflection, age had been shown to be negatively correlated with completion in the prior statewide study as well (see Phillips, Spurling and Armstrong 2002, 26). It may be that age serves as a surrogate variable for certain life experiences that might hinder the performance of older students. These possible barriers to success might include a greater presence of family and marital commitments that limit study time, a greater tendency to be employed while pursuing their nursing studies, and perhaps the impact of returning to coursework that may not be as “fresh” in the mind as with younger students. While the age and science GPA variables were the only significant variables in the equation, the two other variables had coefficients in the anticipated direction. That is to say,

¹ A number of model fit statistics are provided at the bottom of Table 2 to suggest a robust model fit. The model correctly classifies nearly 80 percent of the student outcomes, which is an eight percent improvement over the modal guessing strategy of always predicting successful completion. The Pseudo R Square measure (Model Chi Square/Model Chi Square + N) surpasses the statistic reported in the statewide study, despite having a sample size one-tenth the size. The measure implies that roughly 9 percent of the variance in the dependent variable is accounted for by the combination of four variables used here.

cumulative GPA was positively associated with successful program completion. Likewise, the greater the number of science repetitions, the lower the probability of success.

Table 2
Maximum Likelihood Logistic Regression Estimates
of Successful Program Completion by Nursing Students, 1997-2002 (N=223)

Variable	b	Stand. Error	prob.
Cumulative GPA	.573	.364	.116
Science Prerequisite GPA	.742 **	.333	.026
Science Course Repetitions	-.229	.140	.103
Age at Program Entry	-.054 **	.022	.014
Intercept	-0.760		
** Statistically significant at $p < .05$			
Negative 2 Log Likelihood Ratio	212.60		
Model Chi Square	22.25		
Percent of Cases Correctly Predicted	79.82		
Proportional Reduction in Error	8.3%		
Pseudo R Square	.09		

In Tables 3 through 6, the logistic regression results are transformed in such a way as to calculate predicted probabilities of successful completion, based on varying levels of independent variables. Some explanatory notes may be helpful. The left side of the tables present the regression coefficients from Table 2. On the right side, a gray column of data is highlighted to introduce a hypothesized change in an independent variable – in Table 3 the science prerequisite GPA is set at different scores, ranging from 2.0 to 4.0 (see also Figure 3). The logistic transformations are calculated in the two neighboring columns, and in the final column we have transformed the impact of the variable to a predicted probability of successful completion.² In Table 3, then, as science GPA increases, the predicted probability of successful

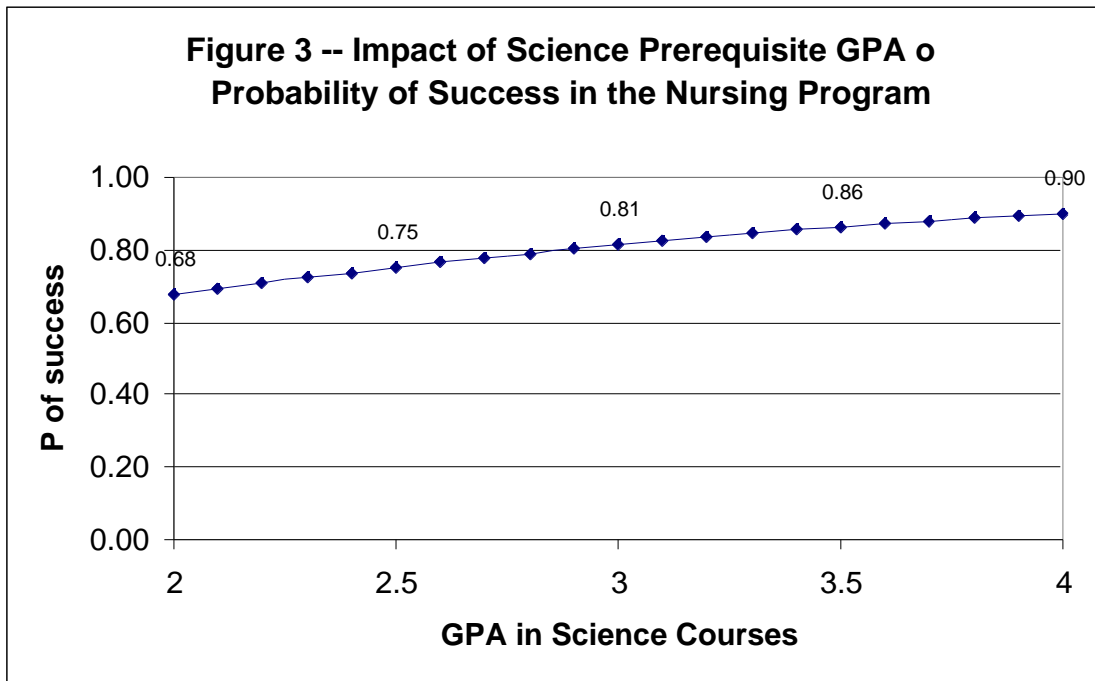
² The equations performed in the columns are simply the “Z score” for the equation (where mean values are plugged in for most independent variables and a predetermined value is plugged in for one “x” variable), and the antilog of the Z Score. The probability calculation is merely the antilog of the Z score divided by 1+ the antilog, generating a score ranging between 0 and 1.0 that reflects the probability of an outcome when a variable is set at a specific level.

completion of the nursing program increases. The range listed is between .68 for a mean student entering with a 2.0 science GPA, to a predicted probability of .90 for a straight A student in science prerequisite courses. In short, holding all other variables constant at the mean, nursing students who entered with a perfect science prerequisite GPA outperformed C level students at a rate of roughly 22 percent more successful completions.

Table 3 -- The Impact of Science GPA on Nursing Program Completion

Logistic Regression Equation Results					Hypothetical Data Calculation Science Prerequisite GPA Changes			
Intercept	Cumulative GPA	Science GPA	Science Repeats	Entry Age	Hypothetical Science GPA	Z Score	Antilog Z (EXP)	Prob. of Success
-0.7597	0.5734	0.7421	-0.2291	-0.0536	2	0.7353	2.0862	0.68
-0.7597	0.5734	0.7421	-0.2291	-0.0536	2.1	0.8096	2.2469	0.69
-0.7597	0.5734	0.7421	-0.2291	-0.0536	2.2	0.8838	2.4200	0.71
-0.7597	0.5734	0.7421	-0.2291	-0.0536	2.3	0.9580	2.6064	0.72
-0.7597	0.5734	0.7421	-0.2291	-0.0536	2.4	1.0322	2.8072	0.74
-0.7597	0.5734	0.7421	-0.2291	-0.0536	2.5	1.1064	3.0234	0.75
-0.7597	0.5734	0.7421	-0.2291	-0.0536	2.6	1.1806	3.2563	0.77
-0.7597	0.5734	0.7421	-0.2291	-0.0536	2.7	1.2548	3.5072	0.78
-0.7597	0.5734	0.7421	-0.2291	-0.0536	2.8	1.3290	3.7774	0.79
-0.7597	0.5734	0.7421	-0.2291	-0.0536	2.9	1.4032	4.0683	0.80
-0.7597	0.5734	0.7421	-0.2291	-0.0536	3	1.4774	4.3817	0.81
-0.7597	0.5734	0.7421	-0.2291	-0.0536	3.1	1.5517	4.7193	0.83
-0.7597	0.5734	0.7421	-0.2291	-0.0536	3.2	1.6259	5.0828	0.84
-0.7597	0.5734	0.7421	-0.2291	-0.0536	3.3	1.7001	5.4744	0.85
-0.7597	0.5734	0.7421	-0.2291	-0.0536	3.4	1.7743	5.8961	0.85
-0.7597	0.5734	0.7421	-0.2291	-0.0536	3.5	1.8485	6.3503	0.86
-0.7597	0.5734	0.7421	-0.2291	-0.0536	3.6	1.9227	6.8394	0.87
-0.7597	0.5734	0.7421	-0.2291	-0.0536	3.7	1.9969	7.3663	0.88
-0.7597	0.5734	0.7421	-0.2291	-0.0536	3.8	2.0711	7.9337	0.89
-0.7597	0.5734	0.7421	-0.2291	-0.0536	3.9	2.1453	8.5449	0.90
-0.7597	0.5734	0.7421	-0.2291	-0.0536	4	2.2195	9.2031	0.90

Probability is calculated assuming average scores on cumulative GPA and science repeats, and age at program entry, then entering different values of science GPA



Similar interpretations can be applied to the data in Tables 4 through 6, and in Figures 4 through 6. Generally speaking, age of student had a substantial impact in the regression model, with older students completing the program at a much lower rate than students between the age of 18 and 30. Holding all other factors constant, students at the mean age of 30 had an 81 percent chance of completing the program, whereas someone entering the program at the age of 50 would only have a 59 percent chance of success (based on this sample of students). Students who were forced to take a number of science course repetitions were much less likely to complete the nursing program successfully. The regression results suggest that a student repeating core science courses four or more times would have less than a 66 percent chance of completing the nursing program. Students entering with no core science repetitions would have an 83 percent chance of success. Similarly, odds of successfully completing the program were enhanced greatly if a student was a 4.0 student overall (cumulative GPA, $p = .88$), as compared

against a 2.0 student ($p = .70$). Again, these calculations assume that the other variables are held constant while examining the impact of one independent variable.³

Table 4 -- The Impact of Age of Student on Nursing Program Completion

Logistic Regression Equation Results					Hypothetical Data Calculation Different Ages at Start of Program				
Intercept	Cumulative GPA	Science GPA	Science Repeats	Entry Age	Hypothetical Age Breaks	Z Score	Antilog Z (EXP)	Prob. of Success	
-0.7597	0.5734	0.7421	-0.2291	-0.0536	18	2.0792	7.9983	0.89	
-0.7597	0.5734	0.7421	-0.2291	-0.0536	20	1.9720	7.1852	0.88	
-0.7597	0.5734	0.7421	-0.2291	-0.0536	22	1.8648	6.4548	0.87	
-0.7597	0.5734	0.7421	-0.2291	-0.0536	24	1.7576	5.7987	0.85	
-0.7597	0.5734	0.7421	-0.2291	-0.0536	26	1.6504	5.2092	0.84	
-0.7597	0.5734	0.7421	-0.2291	-0.0536	28	1.5432	4.6797	0.82	
-0.7597	0.5734	0.7421	-0.2291	-0.0536	30	1.4360	4.2040	0.81	
-0.7597	0.5734	0.7421	-0.2291	-0.0536	32	1.3288	3.7766	0.79	
-0.7597	0.5734	0.7421	-0.2291	-0.0536	34	1.2216	3.3927	0.77	
-0.7597	0.5734	0.7421	-0.2291	-0.0536	36	1.1144	3.0478	0.75	
-0.7597	0.5734	0.7421	-0.2291	-0.0536	38	1.0072	2.7380	0.73	
-0.7597	0.5734	0.7421	-0.2291	-0.0536	40	0.9000	2.4597	0.71	
-0.7597	0.5734	0.7421	-0.2291	-0.0536	42	0.7928	2.2096	0.69	
-0.7597	0.5734	0.7421	-0.2291	-0.0536	44	0.6856	1.9850	0.66	
-0.7597	0.5734	0.7421	-0.2291	-0.0536	46	0.5784	1.7832	0.64	
-0.7597	0.5734	0.7421	-0.2291	-0.0536	48	0.4712	1.6020	0.62	
-0.7597	0.5734	0.7421	-0.2291	-0.0536	50	0.3640	1.4391	0.59	
-0.7597	0.5734	0.7421	-0.2291	-0.0536	52	0.2568	1.2928	0.56	
-0.7597	0.5734	0.7421	-0.2291	-0.0536	54	0.1496	1.1614	0.54	
-0.7597	0.5734	0.7421	-0.2291	-0.0536	56	0.0424	1.0433	0.51	
-0.7597	0.5734	0.7421	-0.2291	-0.0536	58	-0.0648	0.9373	0.48	
-0.7597	0.5734	0.7421	-0.2291	-0.0536	60	-0.1720	0.8420	0.46	

Probability is calculated assuming average scores on science GPA and science repeats, and cumulative GPA, then entering different values of Age at the start of the program

³ It should be noted that we examined the impact of the English 1A prerequisite for recent nursing students on a separate sub-sample. When analyzing the data for this subset of 164 students, we found no statistically significant association between performance in English 1A GPA and successful completion of the nursing program. Indeed, when controlling for other variables, the impact of English 1A GPA was in the unexpected direction, suggesting no relationship whatsoever between the English course prerequisite and nursing success. Such a finding provides strong evidence that science course success is a much better predictor of nursing program completion.

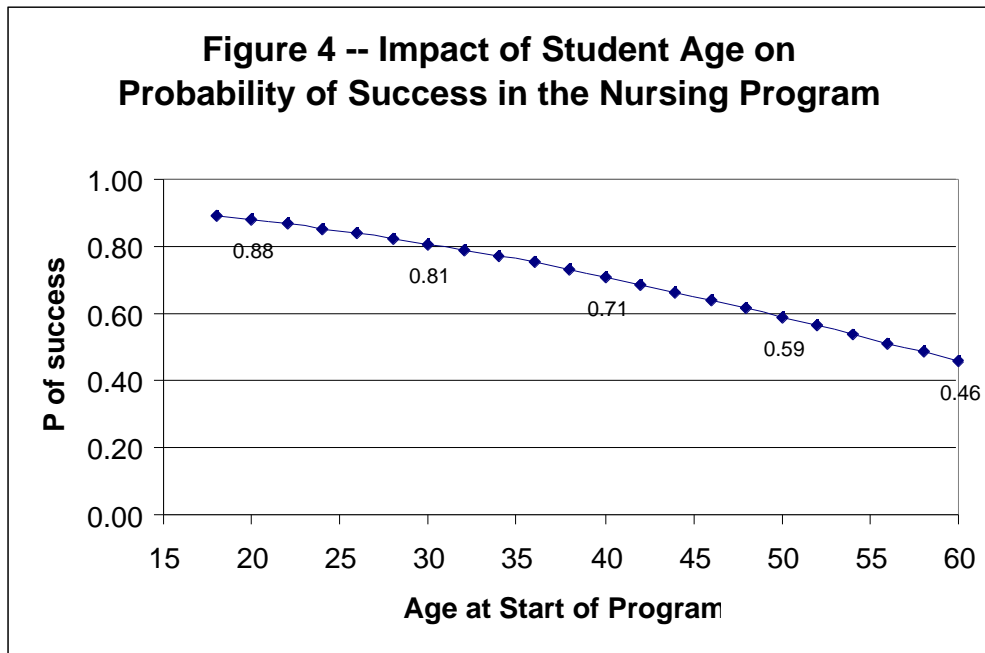


Table 5 -- The Impact of Science Course Repetitions on Nursing Program Completion

Logistic Regression Equation Results					Hypothetical Data Calculation Repetitions of Science Prerequisites			
Intercept	Cumulative GPA	Science GPA	Science Repeats	Entry Age	Hypothetical # of Repeats	Z Score	Antilog Z (EXP)	Prob. of Success
-0.7597	0.5734	0.7421	-0.2291	-0.0536	0	1.5644	4.7799	0.83
-0.7597	0.5734	0.7421	-0.2291	-0.0536	1	1.3353	3.8012	0.79
-0.7597	0.5734	0.7421	-0.2291	-0.0536	2	1.1062	3.0229	0.75
-0.7597	0.5734	0.7421	-0.2291	-0.0536	3	0.8771	2.4040	0.71
-0.7597	0.5734	0.7421	-0.2291	-0.0536	4	0.6480	1.9118	0.66
-0.7597	0.5734	0.7421	-0.2291	-0.0536	5	0.4189	1.5203	0.60
-0.7597	0.5734	0.7421	-0.2291	-0.0536	6	0.1898	1.2090	0.55
-0.7597	0.5734	0.7421	-0.2291	-0.0536	7	-0.0393	0.9615	0.49
-0.7597	0.5734	0.7421	-0.2291	-0.0536	8	-0.2684	0.7646	0.43

Probability is calculated assuming average scores on science GPA, cumulative GPA, and age of student at entry, then entering different values of science course repeats

Figure 5 -- Impact of Repeating Science Prerequisites on Probability of Success in the Nursing Program

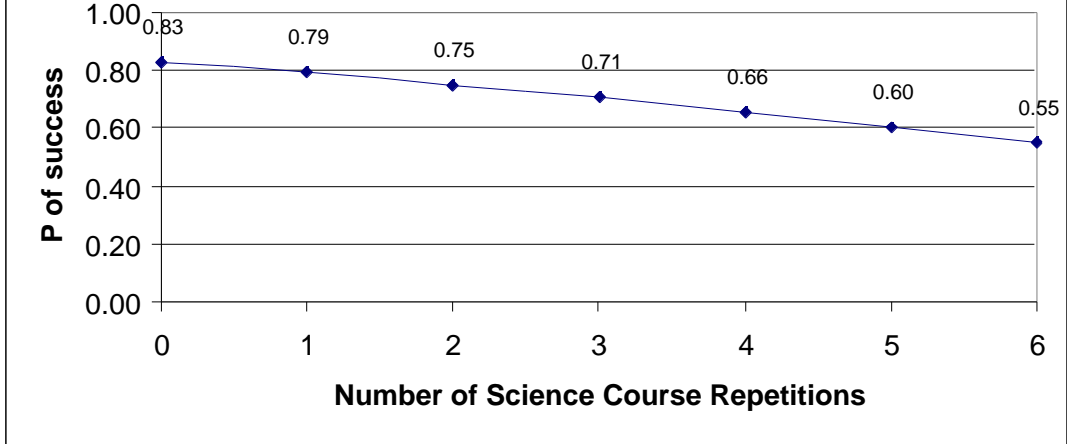
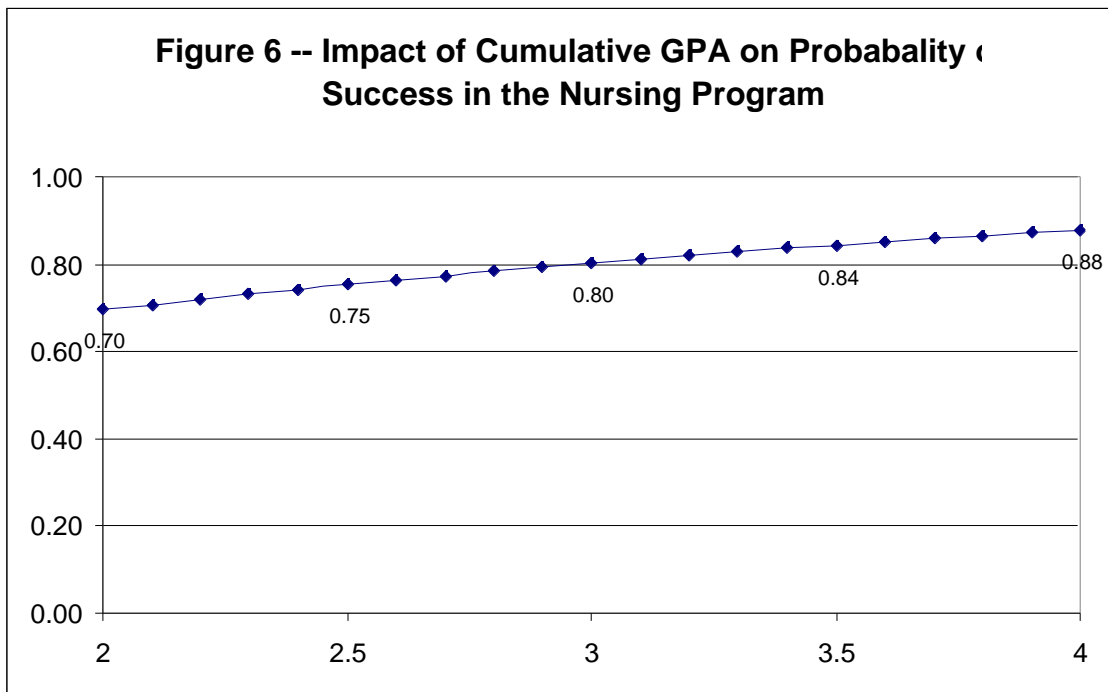


Table 6 -- The Impact of Cumulative GPA on Nursing Program Completion

Logistic Regression Equation Results					Hypothetical Data Calculation Cumulative GPA Changes			
Intercept	Cumulative GPA	Science GPA	Science Repeats	Entry Age	Hypothetical Cum GPA	Z Score	Antilog Z (EXP)	Prob. of Success
-0.7597	0.5734	0.7421	-0.2291	-0.0536	2	0.8263	2.2848	0.70
-0.7597	0.5734	0.7421	-0.2291	-0.0536	2.1	0.8836	2.4196	0.71
-0.7597	0.5734	0.7421	-0.2291	-0.0536	2.2	0.9409	2.5624	0.72
-0.7597	0.5734	0.7421	-0.2291	-0.0536	2.3	0.9983	2.7136	0.73
-0.7597	0.5734	0.7421	-0.2291	-0.0536	2.4	1.0556	2.8738	0.74
-0.7597	0.5734	0.7421	-0.2291	-0.0536	2.5	1.1130	3.0434	0.75
-0.7597	0.5734	0.7421	-0.2291	-0.0536	2.6	1.1703	3.2230	0.76
-0.7597	0.5734	0.7421	-0.2291	-0.0536	2.7	1.2276	3.4132	0.77
-0.7597	0.5734	0.7421	-0.2291	-0.0536	2.8	1.2850	3.6146	0.78
-0.7597	0.5734	0.7421	-0.2291	-0.0536	2.9	1.3423	3.8279	0.79
-0.7597	0.5734	0.7421	-0.2291	-0.0536	3	1.3997	4.0538	0.80
-0.7597	0.5734	0.7421	-0.2291	-0.0536	3.1	1.4570	4.2931	0.81
-0.7597	0.5734	0.7421	-0.2291	-0.0536	3.2	1.5143	4.5464	0.82
-0.7597	0.5734	0.7421	-0.2291	-0.0536	3.3	1.5717	4.8147	0.83
-0.7597	0.5734	0.7421	-0.2291	-0.0536	3.4	1.6290	5.0989	0.84
-0.7597	0.5734	0.7421	-0.2291	-0.0536	3.5	1.6864	5.3998	0.84
-0.7597	0.5734	0.7421	-0.2291	-0.0536	3.6	1.7437	5.7185	0.85
-0.7597	0.5734	0.7421	-0.2291	-0.0536	3.7	1.8010	6.0560	0.86
-0.7597	0.5734	0.7421	-0.2291	-0.0536	3.8	1.8584	6.4134	0.87
-0.7597	0.5734	0.7421	-0.2291	-0.0536	3.9	1.9157	6.7918	0.87
-0.7597	0.5734	0.7421	-0.2291	-0.0536	4	1.9731	7.1927	0.88



Conclusion

Following the lead of recent scholarship, this study set out to examine the impact of several independent variables on the completion rates of students admitted to the nursing program at Delta College. As in prior work, performance in science prerequisite course work proved to be one of the most powerful predictors of nursing program completion. Age of student also served to play a significant role, with older students completing the program at much lower rates. While two other measures of academic performance (science course repetition and cumulative GPA) were not statistically significant, their association with program completion tracked with the expected values.

Several important conclusions can be drawn from this study. First, if nursing faculty desired to establish some form of “cut score” method for admission to the nursing program, it

seems clear that science prerequisite GPA could serve the role as a powerful, singular benchmark for admission processes. This is true because of the strong association between the two variables. Assuming that nursing faculty might want to establish some predetermined level of successful completion as a benchmark for all students to attain (say 70 percent), then patterns from the 1997-99 cohort of students suggests that a science GPA benchmark of 2.2 could serve as a threshold for most students to attain entry into the program. In short, if the desire is to admit students with only a 70 percent chance of success or higher, a science prerequisite GPA of 2.2 could serve as a yardstick for entry into the admission pool for the average student.

Nursing faculty might also use a tandem of variables to construct a hypothetical admission “grid” that prospective students could examine. Using a set of hypothetical examples, students might be admitted if they have a 2.0 science prerequisite GPA and did not have to repeat any of the coursework. Meanwhile, students having to repeat one science course might be admitted with a 2.3 GPA or higher. Students having to repeat two science courses might be allowed into the admission pool if they maintained a GPA of 2.6 or higher in the prerequisite courses. In short, the faculty might construct a table of cells into which students must fall to enter into the admission pool, based on a combination of science GPA and science course repetitions. Such an approach is listed in Table 7, which provides a matrix of cells predicting successful student completion based on science course GPA and science course repetitions.

Table 7
Probability of Successful Completion of the Nursing Program Within 3 Years

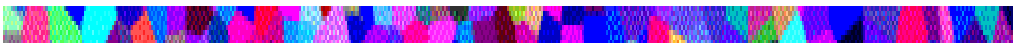
Science Prerequisite GPA	Number of Science Prerequisite Repetitions						
	0	1	2	3	4	5	6
2.0	70%	65%	60%	54%	49%	43%	38%
2.1	72%	67%	62%	56%	51%	45%	39%
2.2	73%	69%	64%	58%	52%	47%	41%
2.3	75%	70%	65%	60%	54%	49%	43%
2.4	76%	72%	67%	62%	56%	50%	45%
2.5	78%	73%	69%	63%	58%	52%	47%
2.6	79%	75%	70%	65%	60%	54%	48%
2.7	80%	76%	72%	67%	62%	56%	50%
2.8	81%	77%	73%	68%	63%	58%	52%
2.9	82%	79%	75%	70%	65%	60%	54%
3.0	83%	80%	76%	72%	67%	61%	56%
3.1	84%	81%	77%	73%	68%	63%	58%
3.2	85%	82%	79%	74%	70%	65%	59%
3.3	86%	83%	80%	76%	71%	67%	61%
3.4	87%	84%	81%	77%	73%	68%	63%
3.5	88%	85%	82%	78%	74%	70%	65%
3.6	89%	86%	83%	80%	76%	71%	66%
3.7	89%	87%	84%	81%	77%	73%	68%
3.8	90%	88%	85%	82%	78%	74%	70%
3.9	91%	89%	86%	83%	80%	76%	71%
4.0	91%	89%	87%	84%	81%	77%	73%

Probability calculations based on a study of 223 nursing students, 1997-2002
 San Joaquin Delta College Office of Planning, Research, and Grants Development

Of course any scheme of this type – if applied to the entire class of applicants – might run contrary to the open access philosophy of the California Community College system. Indeed, application of the 2.2 GPA benchmark in a post hoc manner to the sample studied here would have resulted in the denial of admission of 33 students who were admitted under the college’s current admissions process (more than 12 percent of the students in the study). Detailed analysis of those 33 students suggests that the 2.2 cut score would have a slightly disproportionate impact

on non-white students. For example, whites made up 55 percent of the students in the nursing study, but only 33 percent of those who had a science prerequisite GPA below 2.2. Conversely, while non-whites made up 44 percent of the students, 66 percent of those below the 2.2 benchmark were minority students. While these numbers may seem dramatically different, chi square tests of statistical significance did not suggest the differences were large enough to reject the possibility of a random effect. In other words, the data did not validate a statistically significant conclusion that the 2.2 GPA would disproportionately exclude non-white students.

Age can certainly **not** be a factor in any admission scheme, because it would clearly represent an act of discrimination to deny admission on the basis of age. However, the results do suggest some potential need for remediation or assistance for older adult students. If older students fail to complete the program at the same rate as younger students, and that seems to be the case, then the faculty might want to initiate a study to examine the factors that contribute to this significant difference. Additionally, some follow-up analysis of RN examination results might be interesting to see if these same age differences carry through to the licensure examination.



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