The relationship between reading preparation level and selected distance-education (DE) content-area course success

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Studying the relationship between students' basic skill preparation level and content-area course success helps inform curriculum process. In October 2017, the Research Office at Sacramento City College (SCC) completed a study on the relationship between English reading preparation and selected content-area course success at the College.[1] The study examines whether students' level of reading preparation and content-area course success are related and whether there is a tipping point in reading preparation level at which the percentage of successful students exceeds that of unsuccessful students in content-area courses. The October study found empirical evidence for a positive relationship between students' reading preparation level and course success in Astronomy 310, Political Science 301, and Psychology 300. Of the five courses examined, only in Astronomy 310 was a tipping point found—in this course, students appeared to be more likely to succeed than not if their reading levels are at college or transfer levels. The relationship was not clear in courses in Chemistry 300 and Sociology 310.

This analysis adds to the October study by incorporating course modality into the analysis. We employed the same dataset and method used in the October study but with an interest in distance education courses (DE), which are online and hybrid courses. In this analysis, course modality includes three categories: online, hybrid, and lecture. Specifically, the categories are defined as follows:

- Online: 100% of class instruction time is online
- Hybrid: 1-99% of class instruction time is online
- Lecture: 0% of class instruction is online

This analysis is exploratory. We examined the online/hybrid subset of the three courses from the previous study—Political Science 301 (POLS 301), Psychology 300 (PSYC 300), and Sociology 310 (SOC 310). We added another Sociology course—Sociology 301 (SOC 301) because the sample size of SOC 310 is small and SOC 301 has similar advisories to those in SOC 310.

First, we looked to answer the following questions:

> Question 1. Is there a relationship between students' English reading preparation level and course success in the selected DE content-area courses?

> Question 2. At which reading preparation level does the percentage of successful students exceed the percentage of unsuccessful students in a given DE content-area course?

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[1] The study can be accessed at https://goo.gl/ghJbGB

Second, we went further to examine whether the relationship between reading preparation levels and course success varies by course modality and content-area courses.

For detailed descriptions of selected courses, dataset, and methods, please refer to Hoang & Cull (2017). Table 1 below summarizes student counts and success rates by course and course modality in this analysis. Note that although we include the "hybrid" category, the N for "hybrid" is very small and only SOC 301 has the hybrid modality. Therefore throughout most of the analysis we will be looking into "online" courses only.

Table 1. Outcome courses, student count and success rate by course modality
Fall 2012 – Spring 2017

	POLS 301		PSYC 300		SOC 310		SOC 301	
	Count	Percent	Count	Percent	Count	Percent	Count	Percent
Enrollment	3,346	100	4,956	100	329	100	862	100
Lecture	2,785	83.234	4,375	88.277	124	37.690	435	50.464
Online	561	16.766	581	11.723	205	62.310	427	49.536
Success	2,273	67.932	3,096	62.470	208	63.222	464	74.942
Lecture	1,843	66.176	2,676	61.166	77	62.097	240	55.172
Online	430	76.649	420	72.289	131	63.902	224*	52.459

* includes 40 students in hybrid

Of the four courses examined, aggregated online enrollment from Fall 2012 to Spring 2017 ranges from 205 (SOC 310) to 581 (PSYC 300). Course overall success rate ranges from about 63% (PSYC 300) to 75% (SOC 301). With the exception of SOC 301, success rates in all of the DE courses examined are higher than that of non-DE courses.

ANALYSIS RESULTS

English reading preparation level and outcome course success

Question 1: Is there a relationship between students' English reading preparation level and outcome course success?

To answer this question, we employed the independent samples t-test to compare the average reading preparation levels between successful and unsuccessful students in the DE content-area courses. A significant test statistic would indicate that the mean reading preparation level of a group is statistically higher or lower than the other group. We also used chi-square test to examine whether success is dependent on levels of reading preparation. Table 2 lists the descriptive statistics and the test results. The last two columns of the table shows whether the test-statistics are significant (Yes-No).

In all of the DE courses and in the overall DE sample, the average reading preparation levels of successful groups appear to be slightly higher than those of unsuccessful groups. However, the difference is only statistically significant in SOC 301 and the overall sample. In other words, the difference observed in the means of reading preparation levels in successful/unsuccessful groups in DE courses POLS 301, PSYC 300, and SOC 310 might have occurred by chance. In SOC 301 and in the overall sample, the means of reading levels of successful groups are statistically higher than unsuccessful groups'. The Chi-square test statistics are not significant in all of the DE courses and in the overall DE sample ($p > .05$), indicating that success in the DE courses and among DE students might not be dependent on the levels of their English reading preparation.[2]

Table 2. Compare Reading Preparation Level of Successful and Unsuccessful Students in DE Content-area Courses

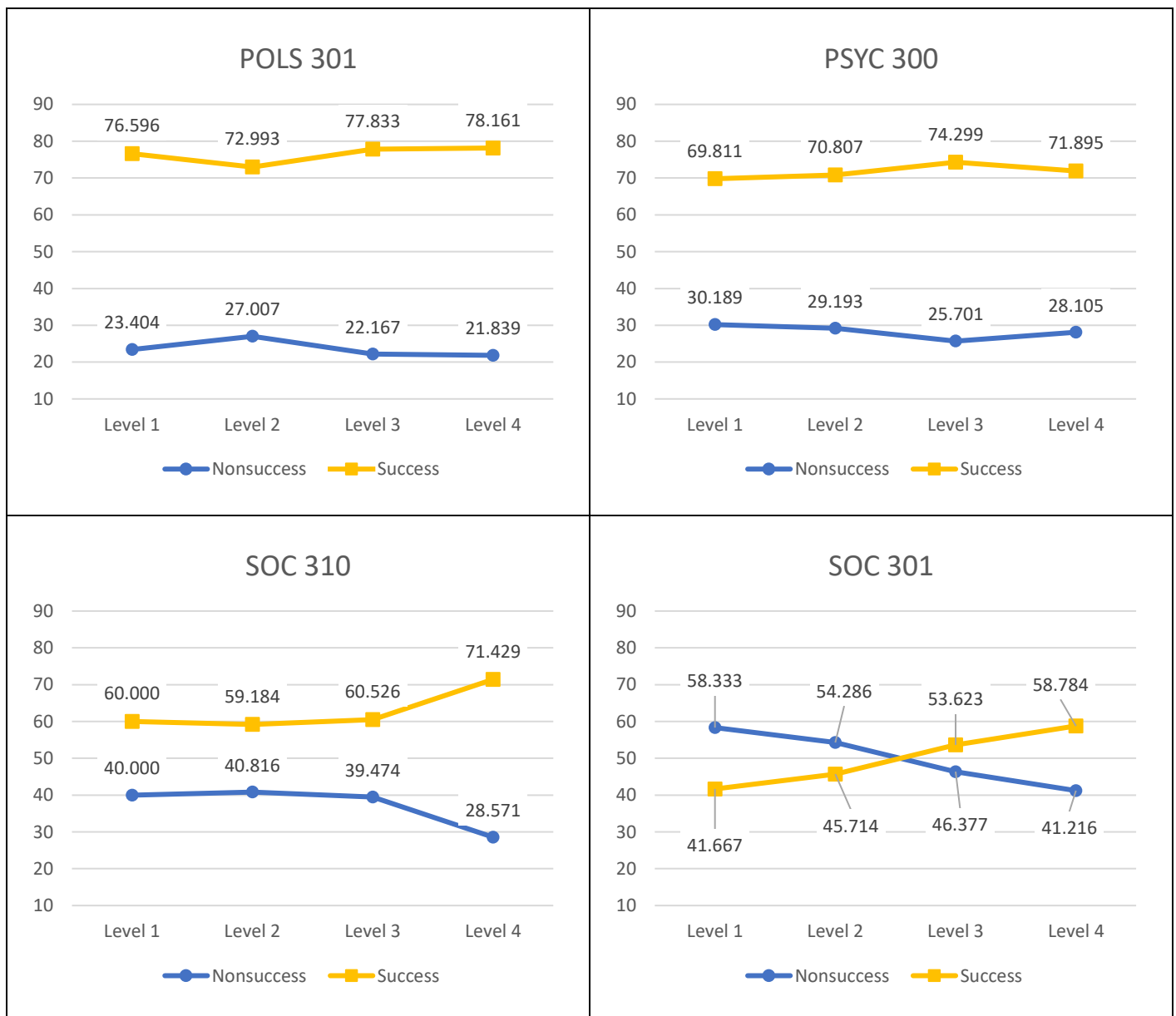| DE course	DE course success	N	Mean of Reading Preparation Level	Standard deviation of Preparation Level	t-test significance (at alpha = .05)	Chi-square test significance (p = .05)
POLS 301	Successful	430	2.916	.937	No	No
	Not successful	131	2.840	.943		
PSYC 300	Successful	420	2.814	.924	No	No
	Not successful	161	2.776	.955		
SOC 310	Successful	131	3.069	.887	No	No
	Not successful	74	2.892	.869		
SOC 301	Successful	224	3.040	.934	Yes	No
	Not successful	203	2.813	.982		
Overall	Successful	1,205	2.920	.930	Yes	No
	Not successful	569	2.819	.950		

Question 2. At which reading preparation level does the percentage of successful students exceed the percentage of unsuccessful students in a given content-area DE course?

To answer this question, we examined the likelihood for success and otherwise at each level of reading preparation in each of the DE courses. A tipping point would be at reading preparation level where the percentage of successful students is higher than 50 percent. Figure 1 below illustrates the likelihood for success at each level of reading preparation in each of the DE courses. In the DE courses in POLS 301, PSYC 300, and SOC 310, the percentages of successful students exceed those of unsuccessful peers even at the lowest reading preparation—Level 1. In SOC 310, the tipping point is at college-prepared level (Level 3), at which the likelihood for success is about 54 percent. These results are in line with findings in Question 1. Although students with the highest level of reading preparation seem to be more likely to succeed than those at the lowest level of

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[2] The t-test and chi-square test statistics were significant for POLS 301 and PSYC 300 in the sample with both DE and non-DE courses in previous study.

reading preparation, the relationship between reading preparation levels and DE course success is not clear in POLS 301, PSYC 300, and SOC 310. Note that the sample size of SOC 310 is very small (N = 10 at Level 1 of reading preparation).

Figure 1. Student Success in selected DE courses by Reading Preparation Level
Fall 2012 – Spring 2017

The analyses above examined the relationship between reading preparation levels and DE course success. The results seem to be consistent with the findings from October study in that the relationship seems to be positive. However, such a relationship is not statistically significant in the

DE courses (except for SOC 301) while being otherwise when course modality was not taken into account in the October study.

The relationship between reading preparation levels and course success by course modality

The discrepancy described above prompted us to examine whether the relationship between reading preparation levels and course success varies by course modality. We employed the generalized linear modeling (GML), i.e. the logistic regression model, to calculate the odd ratios for course success by reading preparation level while accounting for course modality and course content areas. Our dependent variable is Success. Our independent variables include Reading Preparation Level, Course Modality, and Content-area Courses. Table 3 describes variable attributes.

Table 3. Variable Attributes

Variable	Type	Attribute
Success	Binary	0 = Nonsuccess 1 = Success
Reading Preparation Level	Ordinal	1 - 4
Modality	Categorical	0 = Lecture (Reference group) 1 = Online 2 = Hybrid
Course	Categorical	0 = POLS 301 (Reference group) 1 = PSYC 300 2 = SOC 310 3 = SOC 301

Using the dataset that includes both DE and non-DE course enrollment in the selected content-area courses that have reading preparation level data,[3] we plotted the GLM model for the predicted probability of success by level of reading preparation (Model 1) with 95% confidence interval. As evident in Figure 2, the probability of success is already above .5 at the lowest level of reading preparation. At each increment of reading preparation level, the predicted probability of success would be expected to increase, though with a somewhat even slope between Level 1 and 2 and becoming slightly moderate from there (blue line). This is consistent with the findings above— even at the lowest level of reading preparation, the likelihood for success is higher than nonsuccess. The area between the two red lines shows the 95% confidence interval (CI), i.e. we can be 95% confident that the CI contains the true probability for success. The smaller the area is, the more we could be confident about the predicted probability.

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[3] The same dataset used in Hoang & Cull (2017)

Figure 2. Predicted Probability of Success by Level of Reading Preparation
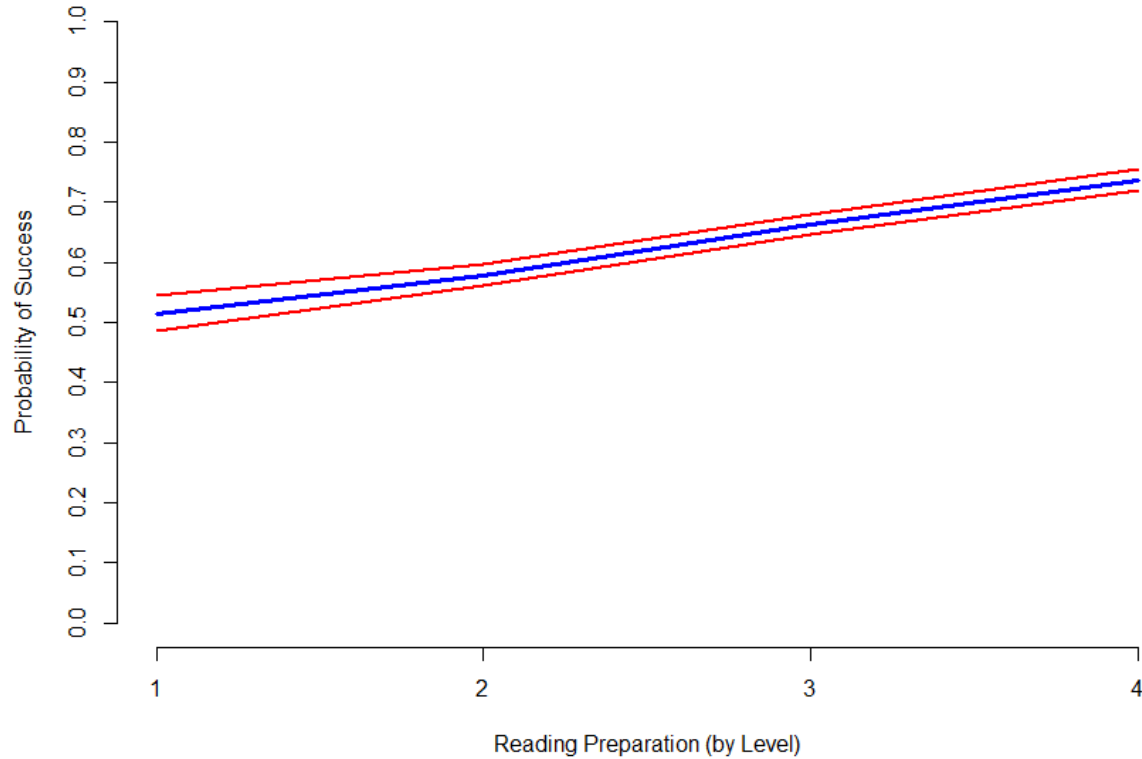
We then added the variables Modality and Course to the GLM model (Model 2). Table 4 summarizes the coefficient estimates for Model 1 and Model 2 in the form of odds ratio.[4] For categorical variables (i.e. Modality and Course) in the regression results for Model 2 in Table 4, each of the coefficient estimate for a given category is interpreted as "compared to the reference group," which is the category with a value of "0" (detailed in Table 3). For example, in the results for Modality, the coefficient estimate for Online would be interpreted as "having an odds ratio of success higher than that of Lecture modality."

To interpret odds ratio, note that an odds ratio of 1 is the baseline for comparison. In other words, when the odds ratio equal to 1, it would be expected that there is no association between the dependent and independent variables. If the odds ratio is smaller than 1, the odds of success are higher for the reference group. Odds ratio larger than 1 indicates that the odds of success are lower for the reference group. The strength of association is higher when the odds ratio is farther from either side of 1.

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[4] Note that the results for coefficient estimates in Table 4 are already converted to odds ratio by taking the exponential of the coefficient, i.e. exp(β).

Table 4. Regression results

Dependent variable: Success		
Independent variables	**Coefficient estimates (odds ratio)**	
	Model 1	**Model 2**
Reading Level	1.398***	1.387***
Modality		
Online		1.245
Hybrid		.923
Course		
PSYC 300		.841***
SOC 301		.499***
SOC 310		.668**
Number of observations	9,493	9,493
Intercept	.720***	.896***
Adjusted McFadden R square	.017	.024
AIC	12232	12156

Significance codes: 0 '***' 0.001 '**'

The results shown in Table 4 confirm the positive relationship between reading preparation levels and the probability of course success. With each increment of reading preparation level, the odds for success would increase by about 40%.[5] In Model 2 when Modality and Course are added, although the odds for success appear to be higher by about 25% for students in online courses compared to lecture courses and lower by about 8% for students in hybrid courses compared to lecture courses, these coefficient estimates are not statistically significant. The difference in the odds for success in courses by modality might have occurred by chance and there is no empirical evidence found for a difference in the odds for success by course modality. However, the odds for success varied in different content-area courses, with PSYC 300, SOC 301 and SOC 310 all having lower odds for success than POLS 301.

Adding Modality and Course into the model (Model 2) seems to help better examine the factors attributing to course success. The independent variables in Model 2 explained about 2.4 percent of the variation in success (R square = .024), an improvement of about .7 percent compared to Model 1 where only Reading Level is included. This is also confirmed by a smaller AIC observed in the second model. Because we only included factors of interest in the model, such as Reading Preparation Level, Modality, and Course, without accounting for other factors that might have an effect on student success, it is natural that the model only explains so much of the variation in success.

The model provides further empirical evidence that confirms the findings in the previous sections: There is a positive relationship between reading preparation level and course success, but note that

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[5] The coefficient estimate for Reading level is 1.398 in model 1 (and 1.387 in model 2 when controlling for course modality and content-area courses). As noted above, this coefficient has been exponentially transformed to indicate odds ratio. In order to express odds ratio as the percentage increase or decrease in the odds for success, subtract the odds ratio by 1 and multiply the result by 100. A negative number indicates a decrease and a positive number indicates an increase in the odds for success. Eg: (1.398 – 1)*100 = 39.8 (approximately 40 percent increase in odds for success).

at the lowest level of reading preparation the likelihood for success would already exceed that of no success in the overall sample and in all of the DE courses but SOC 301. Another important finding is that the odds for success do not vary by course modality, which is expected as the College is required to ensure course contents are consistent across course modality.