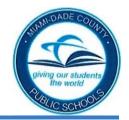# Research Note

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Using Grade 9 Assessment Results to Determine Student Potential for Success on the Advanced Placement Exams

Student Data Used

Assessment results of students who were in grade 9 during the 2016-2017 school year were used in this project. These included student scale scores on the Florida State Assessment in English Language Arts (ELA) as well as the End-of-Course (EOC) assessment results in Algebra 1, Geometry, and Biology. In addition, the 2017-2018 and 2018-2019 Advanced Placement (AP) examination results of the subgroup of these students who participated in at least one of the AP exams were used.

Selecting Predictors

To determine the suitable predictors of success on the AP exams among the 2016-2017 grade 9 student assessment results in (1) ELA, (2) Algebra 1, (3) Geometry, or (4) Biology, a correlation analysis relating the scale scores on those assessments with the AP exam results (ranging from 1 to 5) was conducted. To enable the stability of correlation analysis results, only the AP exams with at least 100 student results on both the AP and at least one of the four potential predictors were used.

The authors of the Statistical Report produced by the College Board on the AP Potential selected .4 as the minimally acceptable value of the correlation coefficient (Zhang, Patel, & Ewing, 2014). This report uses the same cutoff for the selection of predictors.[1]

The results of this analysis for those AP exams in which the value of at least one of the Pearson correlation coefficients was at least .4 are shown in the table below. The text in the cells corresponding to the assessment results(s) identified as good predictors of AP success is shown in bold font in the table above. The decision about which predictor(s) should be used was based on three factors: (1) the size of the correlation coefficient, (2) the results of the statistical significance testing in the subsequent binary logistic regression analysis, and (3) the classification table accuracy criterion.

For example, in the case of the AP Calculus AB exam, two predictors were selected initially: Biology and Geometry EOCs. However, subsequent analysis showed that only one of them (Geometry EOC) was a statistically significant predictor of success on the AP exam.

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[1] The correlation coefficient value of .5 or higher is generally considered as indicating a strong correlation, while .3 as indicating a moderate correlation.

AP EXAM	Statistic	FSA ELA	ALGEBRA1	BIOLOGY	GEOMETRY
BIOLOGY	Correlation	0.595	0.567	**0.653**	**0.623**
	N	1224	225	**516**	**590**
CALCULUS AB	Correlation	0.374	0.493	0.454	**0.577**
	N	1089	40	229	**138**
CAPSTONE SEMINAR	Correlation	**0.486**	0.346	0.408	0.400
	N	**971**	225	499	536
CHEMISTRY	Correlation	0.488	0.632	**0.577**	**0.576**
	N	620	54	**231**	**255**
COMPUTER SCIENCE A	Correlation	**0.563**	0.309	0.580	0.770
	N	**110**	17	53	54
COMPUTER SCIENCE PRINCIPLES	Correlation	**0.645**	0.425	0.660	**0.589**
	N	**383**	140	172	**156**
ENGLISH LANGUAGE & COMPOSITION	Correlation	**0.617**	0.407	0.496	0.478
	N	**3856**	928	1908	1895
ENGLISH LITERATURE & COMPOSITION	Correlation	**0.607**	0.338	0.471	0.440
	N	**844**	118	531	480
ENVIRONMENTAL SCIENCE	Correlation	0.539	0.475	**0.565**	**0.596**
	N	916	158	**447**	**489**
EUROPEAN HISTORY	Correlation	**0.607**	0.519	0.561	0.498
	N	**1289**	188	657	680
GOVERNMENT & POLITICS: UNITED STATES	Correlation	**0.613**	0.627	0.517	0.557
	N	**552**	33	289	230
HUMAN GEOGRAPHY	Correlation	**0.568**	0.411	0.594	0.506
	N	**2292**	657	1137	1067
MACROECONOMICS	Correlation	**0.620**	0.865	0.582	0.54
	N	**196**	9	42	53
PHYSICS 1	Correlation	**0.530**	0.842	0.550	0.572
	N	**208**	23	73	83
PSYCHOLOGY	Correlation	**0.562**	0.460	0.544	0.520
	N	**2463**	775	1332	1249
STATISTICS	Correlation	**0.491**	0.646	0.366	0.657
	N	**216**	24	59	77
UNITED STATES HISTORY	Correlation	**0.575**	0.450	0.517	0.485
	N	**3343**	757	1666	1676
WORLD HISTORY	Correlation	**0.568**	0.453	0.439	0.545
	N	**123**	50	56	63

Binary Logistic Regression Analysis

The following multistep approach was used in this analysis:

1. The scores on the AP exams were dichotomized with scores of 3-5 indicating success and scores of 1-2 indicating failure.
2. Binary logistic regression in which the dichotomous AP exam score was the outcome, and the predictor was a score on the FSA ELA or a combination of scores on FSA ELA, Biology and/or Geometry EOC, as indicated in the previous table, was executed.
3. The probability of success on each of the AP exams shown in the previous table was calculated.

To determine the goodness-of-fit of the model, the Tjur's pseudo R-squared statistic (Tjur, 2012) was calculated for each of the binary logistic regression models (see the table below). This statistic attempts to measure the strength of association between the outcome and predictor in the logistic regression model. This statistic can be interpreted as the difference in the average expected proportions of success between the actual success and failure cases. For example, of the students who passed the AP Biology exam, the expected proportion of success predicted by the model was 65.3% while among those who failed the test, it was 30.7%. The difference between these two percentages, expressed as a decimal, is the Tjur's pseudo R-squared. It is shown in the table below.

AP EXAM	Pseudo R-squared
BIOLOGY	.35
CALCULUS AB	.20
CAPSTONE SEMINAR	.17
CHEMISTRY	.19
COMPUTER SCIENCE A	.20
COMPUTER SCIENCE PRINCIPLES	.39
ENGLISH LANGUAGE & COMPOSITION	.30
ENGLISH LITERATURE & COMPOSITION	.29
ENVIRONMENTAL SCIENCE	.30
EUROPEAN HISTORY	.29
GOVERNMENT & POLITICS: UNITED STATES	.26
HUMAN GEOGRAPHY	.24
MACROECONOMICS	.37
PHYSICS 1	.22
PSYCHOLOGY	.23
STATISTICS	.17
UNITED STATES HISTORY	.26
WORLD HISTORY	.28

The values of the Tjur's pseudo R-squared statistic ranged from .17 to .39 with the median value of .26. These results were very similar to the results of the College Board study on the AP Potential (Zhang, Patel, & Ewing, 2014). In that study, the reported values of the pseudo R- squared ranged from .15 to .42 with the median value of .27.[2]

The usefulness of each of the binary logistic regression model as a predictor of success or failure on the AP exams was evaluated based on the Proportional Chance Criterion. This criterion uses the classification table produced by the binary logistic procedure and compares the accuracy of the prediction (with the cutoff value on the predicted probability of .5) with that expected by chance. Generally, a prediction is considered useful if the accuracy rate exceeds the proportional chance accuracy rate by at least 25%.

In the present study, the accuracy of the prediction for the Capstone Seminar exceeded the chance accuracy by approximately 25%. In all other cases, the prediction accuracy exceeded the chance accuracy by more than 25%. This "excess percentage beyond chance" varied from 32% to 53%.

Identifying Students for a Recommendation for Enrollment in Certain AP Courses

Students whose estimated probability of success on an AP exam was at least .6 were selected for an enrollment recommendation. The choice of this value was made because it is commonly used in similar situations. For example, when selecting the cut scores for the District's Interim Assessment (IA), the same value of the estimated probability of scoring proficient on the FSA is used to determine the minimum IA score indicating sufficient progress.

The table below shows the minimum scale scores on the FSA ELA or Geometry EOC assessments indicating the potential for success for each of the AP courses in which a single predictor was used.

For a reference, these are the relevant ranges of scale scores corresponding to the Achievement Levels:

- FSA ELA in Grade 9
  - 355-369 Level 4
  - 370-407 Level 5
- Geometry EOC
  - 533-575 Level 5

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[2] The authors of the College Board study used the Cox and Shell' pseudo R-squared.

AP EXAM	FSA ELA	Geometry
CALCULUS AB		533
CAPSTONE SEMINAR	354	
COMPUTER SCIENCE A	369	
ENGLISH LANGUAGE & COMPOSITION	367	
ENGLISH LITERATURE & COMPOSITION	374	
EUROPEAN HISTORY	375	
GOVERNMENT & POLITICS: UNITED STATES	377	
HUMAN GEOGRAPHY	370	
MACROECONOMICS	385	
PHYSICS 1	384	
PSYCHOLOGY	365	
STATISTICS	371	
UNITED STATES HISTORY	370	
WORLD HISTORY	373	

As to the AP exams for which more than one predictor was used, the prediction equation generated by the binary logistic regression was used to derive the required linear combination of the predictors for an AP recommendation.

For example, in the case of Biology AP exam, the prediction equation was

Logodds (success) = -76.292+0.090*Biology+0.071*Geometry.

The selected minimum value for the predicted probability of success is .6, which corresponds to the odds of success of 3:2. Substituting this value to the left-hand side of the equation and taking the natural logarithm produces an equation that can be simplified to derive a criterion that uses a linear combination of the two predictor scores.

This and similar criteria for recommendations for AP enrollment are as follows:

- BIOLOGY   9*Biology score + 7*Geometry score ≥7700
- CHEMISTRY   4*Biology score + 1.75*Geometry score ≥2700
- ENVIRONMENTAL SCIENCE   7*Biology score + 9.5*Geometry score ≥7955
- COMPUTER SCIENCE PRINCIPLES   11*ELA score + 6*Geometry score ≥6948

These criteria and the minimum scale scores in the table above can be used to create a report of grade 10 students who have the potential to succeed in the AP courses.

It should be noted that for all AP examinations not listed in in the table on p. 2 no statistically significant prediction of success on any of them proved possible.

Discussion

The list of students who have the potential to succeed in the AP courses should be used cautiously. It should not be used as a sole reason to recommend any student for any AP course enrollment. Clearly, students should complete any prerequisite course and have a strong interest in pursuing AP enrollment. In addition, a teacher recommendation should be considered. On the other hand, an absence of any student name on the list of students with AP potential should not be taken as an indication that the student is not likely to succeed in an AP course.

It should be noted that this study is limited by the fact that it used the data on students who took the AP courses. These students may be qualitatively different from those who did not take any AP courses in terms of student motivation, parent support, or any other variable that could influence the chances of success on an AP course but could not be considered.

References

Tjur, T. (2012). Coefficients of Determination in Logistic Regression Models - A New Proposal: The Coefficient of Discrimination. *The American Statistician, 63*(4), 366-372.

Zhang, X., Patel, P., & Ewing, M. (2014). *AP Potential Predicted by PSAT/NMSQT Scores Using Logistic Regression.* College Board Research.