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ACT Test Performance by Advanced Placement Students in Memphis City Schools

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ABSTRACT. The authors investigated the extent to which taking specific types of Advanced Placement (AP) courses and the number of courses taken predicts the likelihood of passing subject benchmarks and earning a score of 19 on the composite score on the ACT test, and examined the role gender plays in the projection. They found evidence that taking an AP mathematics course and taking more AP courses derives a positive benefit. Results suggest young men are more likely to succeed in passing ACT mathematics and ACT science tests than are young women, but no gender difference was found on ACT Reading and ACT social studies.

Keywords: ACT, AP English, AP mathematics, AP science, AP social studies, benchmark

The Advanced Placement (AP) program is designed as an educational endeavor to provide motivated high school students with the opportunity to take college-level courses when they are in high school. Since its inception (1955) in secondary schools, it has grown tremendously. Nowadays, there are 39 AP courses in various subject areas, and nearly 60% of U.S. high schools participate in the AP program. In 2006, 2007, and 2008, 1,339,282; 1,464,254; and 1,580,821 students took AP courses, and 2,312,611; 2,533,431; and 2,736,445 students took AP examinations (College Board, 2008a), respectively. This trend makes parents and educational professionals believe that the AP program is a good vehicle for the promotion of educational excellence. Although taking AP classes is not required for a high school diploma, schools are under pressure to allocate limited resources to provide more AP courses, and students are motivated to take more AP courses in order to earn some advantages (Klopfenstein & Thomas, 2009; Santoli, 2002).

There are several advantages to taking AP courses. A few studies (College Board, 2008b; Klopfenstein & Thomas, 2009) have reported that the AP-taking experience has a positive impact on academic performance and retention for college students. The Trends in International Mathematics and Science Study (TIMSS; Gonzalez, O'Connor, & Miles, 2001) examined the relationship between taking AP courses and students' academic achievement and found that students in the United States were lagging behind other students around the world in mathematics and science. After taking relevant AP courses, even students who earned AP calculus grades of 1 or 2 (1 represents earning no recommendation, and 2 represents being possibly qualified) demonstrated the same level of mathematics achievement as students from the top performing nation (France); those students who earned AP physics grades of only 1 or 2 scored behind students from the top two nations (Norway and Sweden). Another study (Breland, Maxey, Gernand, Cumming, & Trapani, 2002) claimed that taking AP courses provided an advantage in relation to college admission: The number of AP courses and the specific type of AP coursework are two of the five most important factors in college admissions.

The rapid growth of AP programs has led to a concern: Does taking AP courses really increase the odds of students being successful in the future? The evaluation of the effect of taking AP courses on students' academic performance helps answer this question. Unfortunately, based on the literature we have reviewed so far, very few studies (Bleske-Rechek, Lubinski, & Benbow, 2004) controlled the initial difference in comparing the academic performance between AP-taking and non-AP-taking groups, which is essential to evaluate the effect of taking AP courses. Because AP was originally designed for highly motivated and intellectually talented students, it is possible that students with higher academic performance are more motivated to take AP courses than are those students with lower academic performance. Even before taking AP courses, the average achievement performance for the AP-taking group

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could be higher than non-AP-taking group. When controlling the achievement difference between AP students and other students before taking AP courses, it is possible to evaluate the effect of taking AP courses on students' educational outcomes. This evaluation information would be valuable to help improve the AP program and to guide students in their course choices. If there is no control of initial difference on the academic performance before taking AP courses, the evaluation of the effects of taking AP courses would be implausible or invalid (Keppel, 1991).

If taking AP courses is beneficial to students, the benefits would be reflected in the educational outcomes such as various achievement test scores. In the present study, we picked ACT test scores as an indicator of the effect of AP test taking and AP involvement. The ACT test aims to measure the extent to which students are ready for success in credit-bearing college courses; it is made up of four separate subject area exams in English, reading, mathematics, and science. It is possible to examine how well the specific type of AP course prepares students for certain ACT subject tests. Students' success on the ACT mathematics test, for example, could be predicted not only by specific courses taken, such as AP English, AP mathematics, AP social studies, and AP science, but also by the total number of AP courses taken, and answer such questions as how well AP classes help students prepare for the ACT test or how the number of AP courses taken by students increases the likelihood of passing the ACT test.

In addition, gender may be a potential factor that interacts with enrollment in AP courses, thus affecting ACT scores. The College Board (2008a, 2008b) indicated that a greater percentage of young men enroll in AP mathematics and AP science courses than young women, whereas a greater percentage of young women enroll in AP English and AP social studies courses. The gender difference in enrollment does not necessarily mean there would be a gender difference on the performance: Young men perform better in mathematics and science than young women, and young women perform better than young men in English reading and social studies (Breland, Danos, Kahn, Kubota, & Bonner, 1994; Moore & Slate, 2002). Due to this concern, another purpose of the present study was to examine the possibility of a gender difference on academic performance in each subject of the ACT test.

To summarize, in the present study we examined whether the likelihood of passing the ACT test was based on one specific type of AP course, the number of AP courses taken, or gender, after controlling the initial difference between the group of students who took AP courses and the group of students who did not take them. The main goal of the study was to evaluate the effects of taking AP courses in a valid way, help the development of AP programs, and guide students' decision making in their course choices. The study focused on Memphis City Schools (MCS) from which the data were pulled.

Method

Participants

MCS is one of the largest urban school districts in the nation. The number of students taking AP courses has steadily increased in recent years. Archival data from MCS for the 2006–2007 and 2007–2008 school years were used in this study. The archival data included three data points: (a) AP courses and course-related variables, which were used as predictors; (b) ACT test scores, which were used as the dependent variable; and (c) Tennessee Comprehensive Assessment Program (TCAP) achievement test scores, which were used to control for achievement differences between groups at the initial stage.

Procedure

First, we dichotomized the ACT scores. ACT raw scores range from 1 to 36. In the present study, we used the benchmark score as a cutoff point to transform all raw scores into dichotomous categories: below benchmark versus equal to or above benchmark. Benchmark scores (ACT website) are predicted to be the minimum ACT test score required for students to have a 50% chance to earn a B or better or a 75% chance to earn a C or better in the corresponding subject area in college courses. Benchmark scores for English, mathematics, social studies, and science are 18, 21, 22, and 24, respectively. The ACT test agency does not set benchmarks for the composite score. Considering that most colleges have a minimum admittance criterion that is equal to or above 19, we used this point to dichotomize composite scores.

Second, we classified AP courses in terms of subject area. In all, there are six categories; however, only the first four categories were used in the analyses in the present study:

1. English AP courses, including English language & composition, English literature & composition, and international English language;
2. mathematics AP courses, including calculus AB, calculus BC, and statistics;
3. social studies AP courses, including U.S. history, art history, European history, human geography, government & politics: United States, government & politics: comparative, and world history;
4. science AP courses, including biology, chemistry, computer science A, computer science AB, environmental science, physics B, physics C–mechanics, and physics C–electricity and magnetism;
5. foreign language AP courses, including French language, French literature, Latin literature, Spanish language, Spanish literature, and Chinese language; and
6. other AP courses including, courses related to art, economics, music, and psychology.

Third, one additional predictor was created, which categorized the number of AP courses taken into three levels:

TABLE 1. Frequency Table of AP Courses, by ACT Subject Area in MCS in the 2006–2008 School Years

	ACT benchmark score									
	English		Mathematic		Social studies		Science		Composite	
Subject	Below	Above	Below	Above	Below	Above	Below	Above	Below	Above
English										
Taking	84	320	252	152	190	214	300	104	134	270
None	572	800	1,226	106	955	417	1,266	106	803	569
Mathematics										
Taking	6	143	32	117	24	125	69	80	7	142
None	81	340	289	132	199	222	330	91	102	319
Social studies										
Taking	28	184	100	112	77	135	139	73	44	168
None	499	739	1,093	145	836	402	1,132	106	694	544
Science										
Taking	34	130	88	76	68	96	107	57	49	115
None	598	753	1,205	146	949	402	1,248	103	794	557
Total	1,902	3,409	4,285	986	3,298	2,013	4,591	720	2,627	2,684

Note. MCS = Memphis City Schools.

zero (not taking AP class), low (taking two or fewer AP classes), and high (taking more than two AP classes).

Finally, certain criteria were set up to select eligible participants in this study. Those students (taking AP group) who took both an AP course since 2006–2007 and the ACT test in 2008 were selected. Along with them, their counterparts (non-AP-taking group) who did not take an AP course but had the equivalent 2006 TCAP scale score as students taking AP courses in at least one subject category and who also took the ACT test in 2008 were selected. One student could take one or several AP courses. This procedure precluded the possibility that the average students taking AP courses already differ from the average students not taking AP courses. This difference may account for any discrepancy in ACT test scores between the AP-taking and non-AP-taking groups.

Statistical Analysis

Because we were interested in the categorical form of ACT scores (passing benchmarks or not) and because we wanted to interpret the results in terms of odds ratio, we used logistic modeling (Agresti, 1990; Hogg & Tanis, 1993; Nunnally, 1994; Pedhazur, 1997). Six factors served as predictors: taking AP English, taking AP mathematics, taking AP science, taking AP social studies, the number of AP courses taken, and gender. The equation can be expressed as

$$ln\left(\frac{p(passing\ benchmark)}{1-p(passing\ benchmark)}\right) = \beta_0 + \beta_1 X_2 + \beta_2 X_2 + \cdots + \beta_6 X_6$$

X_1–X_4 indicate whether the student took AP English, AP mathematics, AP science, or AP social studies, respectively; X_5 indicates the number of AP courses taken; and X_6 denotes gender. The intercept β_0 is the *ln* (odds) of the passing benchmark in the ACT tests when all Xs are 0. Coefficient β_s estimates the change in the *ln* (odds) of passing benchmark in the ACT tests per unit increase in variable X.

Results

Table 1 displays the number of students in the study distributed by the type of AP course and ACT subject areas. Among all students, 529 students were taking AP English, 290 were not taking AP English; 187 students were taking AP mathematics, and 632 were not taking AP mathematics; 285 students were taking AP social studies, and 534 were not taking AP social studies; and 221 students were taking AP science compared with 598 not taking AP science. Table 2 classifies the number of students selected in each ACT subject tests by gender and number of AP courses.

Thereafter, a series of binomial logistic models were created as the dependent variable, varied from passing English benchmark, mathematics benchmark, social studies benchmark, science benchmark, to passing a 19 composite score in ACT test. Estimated odds ratio values are displayed in Table 3, and detailed explanations were framed in terms of four subject benchmarks and a composite 19 score in the ACT test.

Examination of the Likelihood of Passing the English Benchmark

The factors that significantly affected students' performance on the ACT English test included having taken AP English, AP mathematics, and having taken at least one

TABLE 2. Frequency of AP Subject, by Gender and Number of AP Courses

Subject	If taking AP	Gender		Number of AP courses	
		Male	Female	Low	High
English	Taking	119	285	253	151
	None	506	866		
Mathematics	Taking	57	92	47	102
	None	193	228		
Social studies	Taking	75	137	98	114
	None	543	695		
Science	Taking	63	101	85	79
	None	628	723		

AP course. Surprisingly, students who did not take an AP English course were 1.672 (95% confidence interval [CI; 1.055, 2.652]) times as likely to pass the English benchmark as students who did. Students who took the AP mathematics course were 2.778 (95% CI [1.121, 6.884]) times as likely to pass the English benchmark as students who did not. Students who took three AP courses or more were 137.392 (95% CI [32.553, 579.878]) times as likely to pass the English benchmark as those who did not take any AP courses. Students who took one or two AP courses were 6.438 (95% CI [4.077, 10.166]) times as likely to pass the English benchmark as those who did not take any AP courses.

Examination of the Likelihood of Passing the Mathematics Benchmark

Taking AP mathematics, taking AP social studies, gender, and taking at least one AP course significantly affected students' performance on the ACT mathematics test. Students who took AP mathematics were 6.020 times (95% CI [3.591, 10.092]) more likely to pass the mathematics benchmark as those who did not. Students who took the AP social studies were 1.754 (95% CI [1.107, 2.779]) times as likely to pass the mathematics benchmark as those who did not. Young men were 1.634 (95% CI [1.251, 2.134]) times as likely to achieve ACT mathematics scores equal to or above the mathematics benchmark as young women. Students who took three AP courses or more were 8.775 (95% CI [4.156, 18.526]) times as likely to pass the English benchmark as those who did not take any AP courses. Students who took one or two AP courses were 1.956 (95% CI [1.260, 3.035]) times as likely to pass the English benchmark as those who did not take any AP courses.

Examination of the Likelihood of Passing the Social Studies Benchmark

Taking AP mathematics and taking at least one AP course significantly affected students' performance on the ACT social studies test. Students who took AP mathematics were 3.194 (95% CI [1.861, 5.481]) times as likely to pass ACT social studies benchmark as those who did not. Students who took more than two AP courses were 23.974 (95% CI [11.181, 51.405]) times as likely to pass ACT social studies benchmark as those who did not, and students who took only one or two AP courses were 3.620 (95% CI [2.508, 5.225])

TABLE 3. Odds Ratio Estimates for Predictors in Model

Passing ACT test	AP English	AP mathematics	AP social studies	AP science	Gender	Number of AP courses	
	Taking vs. Nontaking	Taking vs. Nontaking	Taking vs. Nontaking	Taking vs. Nontaking	Young man vs. Young woman	< 2 vs. 0	> 3 vs. 0
English	−1.672*	2.778*	0.959	0.603	0.912	6.438**	137.392**
Mathematics	0.885	6.020**	1.754*	1.087	1.634*	1.956**	8.775**
Social studies	0.685	3.194**	1.074	0.796	1.109	3.620**	23.974**
Science	0.912	3.490**	1.341	1.337	1.982**	3.342**	10.681**
Composite	1.996**	5.038**	0.994	0.536	1.081	7.233**	108.127**

Note. − = indicates reverse the reference group for the purpose of interpretation.
*$p < .05$. **$p < .01$.

times as likely to pass ACT social studies benchmark as those who did not.

Examination of the Likelihood of Passing Science Benchmark

Taking AP mathematics, gender, and the number of AP courses taken were factors that significantly affected students' performance on the ACT science test. Students who took AP mathematics were 3.490 (95% CI [2.167, 5.619]) times as likely to pass the ACT science benchmark as those who did not. Young men were 1.982 (95% CI [1.489, 2.640]) times as likely to pass ACT science benchmark as young women. Students who took more than two AP courses were 10.681 (95% CI [4.993, 22.851]) times as likely to pass the science benchmark as those who did not, and students who took only one or two AP courses were 3.342 (95% CI [2.123, 5.262]) times as likely to pass ACT science benchmark as those who did not.

Examination of the Likelihood of Passing Composite Benchmark

Taking AP English, taking AP mathematics, and the amount of AP involvement made significant contributions to students' composite scores. Students who took AP English were 1.996 (95% CI [1.316, 3.030]) times as likely to achieve an ACT composite score equal to or greater than 19 as those who did not. Students who took AP mathematics were 5.038 (95% CI [2.193, 11.575]) times as likely to achieve an ACT composite score equal to or greater than 19 as those who did not; students who took more than two AP courses were 108.127 (95% CI [38.016, 307.543]) times as likely to achieve an ACT composite score equal to or greater than 19 as those who did not; students who took only one or two AP courses were 7.233 (95% CI [4.823, 10.845]) times as likely to achieve an ACT composite score equal to or greater than 19 as those who did not.

Discussion

Taking AP English did not help increase the possibility of passing ACT English or other subject benchmarks on the ACT test; however, it did factor into having an ACT composite score of 19 or greater. This may suggest that gaining knowledge of English is a long-term process. It is not realistic to expect students to improve English in a relatively short period of time, although it is helpful in a long run. Also, it may suggest that students who chose to take AP English classes could have lower propensity or interest in AP mathematics and AP science.

One important finding is that taking AP mathematics greatly increased the likelihood of passing all subject benchmarks and achieving a composite score of 19 or above on the ACT test. One reasonable presumption is that the critical and logical thinking developed in AP mathematics classes is the core part of general aptitude, which ensures students' success in studying all subjects.

Taking AP social studies did not help students pass the ACT social studies benchmark or other subjects, but it did help them pass ACT mathematics. This may be due to the nature of social studies, which puts more emphasis on knowledge rather than critical thinking; however, this cannot explain why taking the AP social studies course helped students pass the mathematics benchmark. One possible reason could be that students who were talented in studying AP mathematics had interests in social studies courses as well, so the same group of students could succeed in ACT mathematics and ACT social studies.

Taking AP science did not help students improve their chances to pass the science and all other subject benchmarks on the ACT test. One possible reason is that AP science courses were not very different from other ordinary science courses, and students did not gain as much critical thinking ability as they did in taking AP mathematics. Future researchers should examine this assumption by analyzing the distribution of AP science course scores and the difference from ordinary science scores after scale equating.

In terms of gender difference, young men were more likely to succeed in passing ACT mathematics and ACT science tests than were young women, which was consistent with the findings of other studies (Breland et al., 1994; Moore & Slate, 2002). We did not, however, find evidence that young women had any advantages in taking ACT English and ACT social studies in comparison with young men.

In general, the more AP courses a student took, the more likely he or she was to succeed in passing the benchmarks in the ACT tests and achieving an ACT composite score of 19 or greater. Taking mathematics greatly helped students in passing all ACT subject benchmarks and achieving a composite score of 19 or greater.

Based on the results of the study, we have the following recommendations. We recommend that schools encourage more students to take AP courses, and also encourage students who have already taken at least one AP course to take more AP courses regardless of the type of subject. One way to achieve this goal is to keep parents and students aware of the benefits of the AP program. Second, because taking an AP mathematics course helps students develop higher order thinking skills and significantly improve the performance in all subjects of the ACT test, schools should allot more resources to train AP mathematics teachers and provide AP mathematics courses. Third, young women should be provided more opportunities to take prerequisite mathematics and science courses in middle schools so that they may have motivation and the necessary foundation to take AP mathematics and AP science courses when they enter high school. Finally, for the group of students who take AP English, schools are encouraged to strengthen their interests in mathematics and science and make the AP science curriculum more challenging as well.

No study comes without limitations, and this study is no exception. For instance, the proportion of students who took AP courses was relatively small compared to the number of

students who took the ACT tests. Future researchers could include a larger sample size in order to further test the generalizable results in the study.

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REFERENCES

Agresti, A. (1990). *Categorical data analysis*. New York, NY: Wiley.

Bleske-Rechek, A., Lubinski, D., & Benbow, C. P. (2004). Meeting the educational needs of special population: Advanced placement's role in developing exceptional human capital. *Psychological Science*, *15*, 217–224.

Breland, H. M., Danos, D. O., Kahn, H. D., Kubota, M. Y., & Bonner, M. W. (1994). Performance versus objective testing and gender: An exploratory study of an Advanced Placement history examination. *Journal of Educational Measurement*, *31*, 275–293.

Breland, H. M., Maxey, J., Gernand, R., Cumming, T., & Trapani, C. (2002). *Trends in college admission: A report of a national survey of undergraduate admission policies, practices, and procedures*. Retrieved from http://airweb.org/images/trendsreport.pdf

College Board. (2008a). *4th annual Advanced Placement report to the nation*. Reston, VA: Author. Retrieved from http://apcentral.collegeboard.com.

College Board. (2008b). *College outcomes comparisons by AP and non-AP high school experience*. Reston, VA: Author. Retrieved from www.collegeeboard.com.

Gonzalez, E. J., O'Connor, K. M., & Miles, J. A. (2001). *How well do Advanced Placement students perform on the TIMSS advanced mathematics and physics tests?* Boston, MA: Boston College, The International Study Center.

Hogg, R. V., & Tanis, E. A. (1993). *Probability and statistical inference*. Englewood Cliffs, NJ: Prentice-Hall.

Keppel, G. (1991). *Design and analysis: A researcher's handbook*. Upper Saddle River, NJ: Simon & Schuster.

Klopfenstein, K., & Thomas, K. M. (2009). The link between Advanced Placement experience and early College success. *Southern Economic Journal*, *75*, 873–891.

Moore, G. W., & Slate, J. R. (2002). Who's taking the Advanced Placement courses and how are they doing: A statewide two-year study. *High School Journal*, *92*(1), 56–67.

Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric theory*. New York, NY: McGraw Hill.

Pedhazur, E. J. (1997). *Multiple regressions in behavioral research*. Orlando, FL: Harcourt.

Santoli, S. P. (2002). Is there Advanced Placement advantage? *American Secondary Education*, *30*(3), 23–35.

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