Effects of Advanced Placement® Science Courses on Students’ Science Interest and Ability: Evaluation from a Randomized Control Trial

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Many of the highest-wage jobs, fastest growing occupations, and public policy challenges in the US and around the world require expertise in science, engineering, and quantitative reasoning (Lacey and Wright, 2009). Yet, national assessments of US 8th graders reveal that only 34% tested at or above proficient in science in 2011 and a slightly lower percent tested at or above proficient in math in 2015 (USDOE 2011; 2016).

Science experts have expressed concern that K-12 science education is disconnected from the real-world practice of science (NRC 2002, 2011). In response to this charge, the College Board (the Board), a non-profit organization that offers several programs for K-12 education, launched a major initiative in 2012 designed to strengthen STEM teaching and learning at the high school level. In collaboration with NSF, the NRC, and educators across the nation, the Board revised its Advanced Placement (AP) science curriculum to better develop students’ ability to conduct in-depth scientific practice.\(^1\) The revised AP curriculum, which represents a large departure from the existing models of science teaching, is designed to emphasize depth of conceptual understanding and application as opposed to the acquisition of limited knowledge in many content areas. In an AP classroom, students are supposed to be guided by teachers to ask questions, develop hypotheses, design experiments, make observations, and communicate their observations to one another – skills that are often referred to as engaging in “scientific inquiry” (College Board 2011b; 2011c). In addition to better preparing students for STEM-related fields, the AP curriculum is intended to spur greater interest and engagement in the practice of science.

In this paper, we report on impact evaluation results from the first experimental study of the AP Program. Our study includes over 1,800 students from across the nation who have been randomly assigned the offer of enrollment to an AP Chemistry or Biology course. We report estimates of the effects of course access and enrollment on students’ scientific inquiry skills and their perceived ability to engage in scientific inquiry, confidence in completing college courses in science, and interest in pursuing a STEM major upon college enrollment.\(^2\)

In addition to providing the first impact estimates of this new approach to scientific instruction, our study is the first to estimate the effect of the AP program in an experimental context. A handful of non-experimental estimates abound, with three well-identified studies in particular that suggest positive effects of the program on education labor market outcomes. Jackson (2010) estimates the effect of the AP Incentive program, which offers cash incentives to teachers and students for passing scores on an AP exam. Jackson identifies effects off of variation in the timing of program implementation across high schools in Texas; his findings indicate that the incentive program not only increased students’ probability of taking an AP course and passing an AP exam, but also increased the number of students’ earning high scores on college entrance exams and enrolling in college (2010). In a follow-up study, Jackson (2014) finds longer-run effects on college completion, employment and earnings. Consistent with these results, Smith,\(^1\) The AP program is a set of college-level courses and exams; in 2015, nearly 4.5 million AP exams were taken by approximately 2.5 million students (College Board, 2016).
\(^2\) The study includes several companion papers, including one that reports on the development and validation of the instrument designed to measure students’ scientific inquiry skills; one that evaluates the quality of course implementation; and one that estimates the effect of AP course access on college enrollment and matriculation (all citations removed).
Hurwitz, and Avery (forthcoming) show in a regression discontinuity context that students who barely earn a college-credit equivalent score on the AP exam complete college more quickly than students who fall just below that score. Taken together, these results suggest that AP course-enrollment, and AP exam success in particular, can have long-lasting impacts on students’ education and labor market outcomes. Our paper contributes to this relatively small body of research by focusing on the unique effect of AP courses on students’ productivity gains (as measured by scientific literacy) as well as their interest in STEM fields.

Research Design

We recruited schools that sought to offer a new AP Biology and/or Chemistry course and that had not offered such a course in recent years. For at least one year (and no more than three years), each school identifies a subset of students that the school deems eligible to take the new AP Biology or Chemistry course. All eligible students who assent to participate in the study and who obtain consent from their parent or guardian are considered study participants. Upon receipt of signed consent/assent forms, the research team randomly assigned a subset of participating students to the offer of enrollment in the new course; these students are considered treatment group members. The study includes 11 school districts, 22 schools, 36 classes, 26 teachers, and 1,877 students.

Data and Analysis

We rely on three primary and secondary data sources. The first is a survey instrument designed and validated by the research team that measures student’s ability to engage in scientific inquiry. Importantly, this instrument is administered to students in both treatment and control groups and is designed to measure general scientific inquiry skills (e.g., how to ask scientific questions, analyze data) rather than test specific content knowledge. Our second data source is a questionnaire of students that includes questions about their coursework, scientific inquiry skills, confidence in their ability to engage in college-level coursework (overall and in science), and plans for the future (e.g., desire to enroll in a 4-year college). The third data source is students’ high school transcripts, which contain background information, grades, courses taken, and high school completion.

We estimate effects of course access with a randomized block design, where the treatment is randomized to students within schools and school effects are fixed as follows:

\[
Y_{ij} = \alpha_j + \beta_1 T_i + X_i \delta_i + \epsilon_{ij},
\]

where \( Y_{ij} \) is the outcome of interest; \( T_i = 1 \) if student \( i \) is randomized into the treatment group and 0 otherwise; \( X_i \) is a vector of pre-treatment covariates drawn from the transcript records (e.g., race/ethnicity, gender, age, eligibility for free or reduced-price lunch); and \( \alpha_j \) are school fixed effects. Standard errors are adjusted for clustering at the school. Equation (1) generates intent to treat (ITT) estimates, which captures the effect of the offer of course enrollment. We then estimate the average treatment effect on the students who enrolled in the course using standard instrumental variables estimation.
References


