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Does Offering More Advanced Placement Courses Increase Enrollment?

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Abstract

This study utilizes a grant in California that required a group of high schools to increase the number of Advanced Placement (AP) courses offered to their students. The grant provides an arguably exogenous increase in the number of AP courses offered in a school. Using an instrumental variable approach, this analysis shows that offering an additional AP course does not increase total enrollment in AP courses. Instead, students substitute out of other AP subjects to enroll in the new subject being offered. This result suggests that additional AP course access is unlikely to induce students to enroll in more AP courses.

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1. Introduction

Research suggests that students receive substantial benefits from taking advanced coursework in high school (Altonji, 1995; Levine and Zimmerman, 1995; Rose and Betts, 2004; Long et al, 2009), but not all students have equal access to advanced courses. Unequal access may put some students at a disadvantage, but it is possible that the cost of offering advanced courses is higher than the benefit in schools with low demand. This paper uses a grant in California to estimate how an arguably exogenous increase to access in advanced placement (AP) courses affects student enrollment in those courses.[1] Results indicate that if a new AP subject is offered, students will enroll in the new subject but do not enroll in a different AP subject that they would have otherwise taken. Through this process, offering a new AP course does not significantly affect total enrollment in AP courses.

In general, schools with higher achieving students offer more advanced courses, which makes it difficult to separate the effect of course access from student demand or school quality. To address this issue, the requirement from California's Advanced Placement Challenge Grant is used as an instrument for variation in access to advanced courses over time. The primary purpose of this grant was to ensure that all high schools meet the standard of offering no less than four total AP courses, with at least one course in both math and science by the 2001-2002 school year. If any school did not meet this standard in the 1999-2000 school year, it was eligible to receive $67,500 over three years and required to expand AP course offerings.

The requirement to increase AP courses through the AP Challenge Grant may still be correlated with unobserved demand for AP enrollment, but it is possible to utilize a nuance of the grant to reduce concerns of endogeneity. The analysis identifies the primary estimates by comparing schools that faced different grant requirements but offered the same number of AP courses before the grant was instituted. By doing this, the only endogeneity that remains is low demand for AP math and science courses, which may result in an underestimation of their effect on enrollment in AP math and science courses. Estimates indicate that an additional AP math or science course significantly increases enrollment in those subjects, in spite of this potential endogeneity. However, the addition of an AP math or science course does not significantly increase enrollment in all AP courses.

These results indicate that additional course access alone does not induce students to enroll in more AP courses. As such, the subject of the advanced courses may be more important than the total number of courses offered. The best use of resources may not be to maximize the number of AP courses offered, but to ensure that the available courses provide the highest possible benefit to students.

2. The AP Challenge Grant

The unequal distribution of AP course offerings prompted the American Civil Liberties Union to file a suit in 1999 on behalf of the students at Inglewood High School in Los Angeles, alleging that their three AP courses were insufficient (Daniel v. California 1999). In response to this lawsuit, the California legislature created the AP Challenge Grant, designed

[1] Offering an additional course is different from adding an additional class. A school may increase the number of classes without offering a new subject.

to increase AP availability and participation within California high schools. The grant was optional for eligible schools and supported three years of funding that amounted to $67,500, starting in the 2000-2001 school year.[2] To be eligible for the grant, a high school had to meet one of four criteria during the 1999-2000 school year: first priority went to high schools that offered less than four total AP courses, second priority went to schools that did not offer either an AP math or an AP science course, third priority went to schools with low college-attendance rates and fourth to schools where the majority of enrolled students were socioeconomically disadvantaged.[3]

In exchange for funding, high schools were required to increase the number of AP courses offered to at least four, with at least one course in both math and science by the 2001-2002 school year. If this requirement was already met, schools were expected to use funding to increase awareness of AP exam subsidies and create programs in high schools and middle schools to prepare students for advanced coursework. No funding was allocated to perform a full review of the program, and there were no penalties for failure to comply with grant requirements. In fact, only 117 of the 288 schools that were required to increase AP access actually met the standard by the designated deadline. A report from grantees about how they used the funding in the first year of the grant (Warren et al. 2001) indicated that funds were spent on staffing, laboratory supplies, textbooks and tutoring, with the majority of funds going toward release time for teachers to attend workshops and obtain other professional development. While it is difficult to trace exactly how grant funds were used, descriptive statistics in the following section show that schools that were required to increase AP courses responded to this requirement.

3. Data and Methodology

There were 906 operational comprehensive high schools when the AP Challenge Grant was first allocated in the 2000-2001 school year. The data that describes high schools are from the California Department of Education (CDE). This department reports the type and number of courses offered in each school and other characteristics of enrollment starting in the 1998-1999 school year. Complete data are available for 813 high schools.[4]

The first complication within the research design is that the AP Challenge Grant was optional. Because of this, the schools that did not receive the grant can be divided into two categories: schools that were not eligible for the grant and schools that were eligible to receive the grant and chose not to accept it. The first two columns of Table 1 describe the number of schools in these two categories by the total number of AP courses the schools offered in the 1999-2000 school year.

[2]Initially funding was meant to be provided for four years and total $75,000. The intention was to allocate $30,000 the first year, $22,500 the second year, and $15,000 the third year. The $7,500 intended for the final year of the program was canceled because of state budgetary issues.

[3]There is no evidence that schools reduced the number of AP courses offered in the 1999-2000 school year to make themselves eligible for the grant.

[4]Schools are not available for a number of reasons. If there are any abnormalities in standardized testing or there are less than 100 students enrolled, then the school's achievement test (API) cannot be reported. Schools that do not report their API are not used in the analysis, as it is impossible to control for their achievement levels. Additionally, alternative high schools are omitted from the analysis.

Table 1:
Number of Schools by Grant Status
and AP Courses Offered in 1999-2000 School Year

Number of AP Courses in 1999-2000 School Year	Non-Grantee		Grantee		Total Schools
	Not Eligible	Eligible	Not Required	Required	
0	0	32	0	43	75
1	0	16	0	33	49
2	0	12	0	35	47
3	0	8	0	43	51
4	8	11	3	42	64
5	23	13	18	36	90
6	18	13	13	22	66
7	27	9	26	15	77
8	30	7	19	11	67
9	25	6	17	5	53
10	30	3	20	2	55
11	21	3	14	1	39
12	20	0	7	0	27
13	13	1	5	0	19
14	6	0	5	0	11
15	9	0	3	0	12
16	5	0	0	0	5
17	1	0	1	0	2
19	4	0	0	0	4
Total Schools	240	134	151	288	813

Non-grantee schools were eligible for the grant if they offered fewer than four AP courses or did not offer both an AP math and AP science course in the 1999-2000 school year. The requirement to increase AP courses is determined by the same criteria.

As illustrated by the first two columns of Table 1, every school that offered fewer than four AP courses in the 1999-2000 school year was eligible for the grant. There are a total 68 schools that offered less than four AP courses and chose not to accept the grant. Any school that was eligible for the grant that offered four or more AP courses was eligible because they lacked either an AP math or and AP science course within their curriculum. There were 66 schools that were eligible based these criteria but did not accept the grant.

The third and fourth columns of Table 1 describe the schools that received the AP Challenge Grant, also divided into two categories. The third column describes the number of schools that received the grant but were not required to increase AP course offerings. The fourth column lists the number of schools that received the grant and were required to increase AP courses. Schools in the fourth column were required to increase AP access because they either offered fewer than four AP courses or did not offer both an AP math and an AP science course in the 1999-2000 school year. Within the data 439 of the 813 schools received the grant.

Table 2: Means for Empirical Sample in the 1999-2000 School Year

	Non-Grantee		Grantee	
Panel A: All Schools	Not Eligible	Eligible	Not Required	Required
Individual Students Enrolled	1,291	896	1,558	907
	(452)	(520)	(619)	(535)
Enrollment in AP Courses	475	159	351	134
	(356)	(184)	(215)	(126)
Academic Performance Index (API)	702	649	580	611
	(99)	(105)	(84)	(92)
Fraction of Students Disadvantaged	22	33	50	39
	(19)	(23)	(25)	(24)
Fraction of Students Caucasian	51	49	32	45
	(25)	(25)	(25)	(29)
Fraction of Schools with AVID Program	35	31	32	30
	(48)	(46)	(49)	(46)
Total Schools	240	134	151	288
Panel B: Schools that Offered Greater than Three AP Courses in the 1999-2000 School Year				
Individual Students Enrolled	1,291	1,130	1,558	1,205
	(452)	(479)	(619)	(450)
Enrollment in AP Courses	475	295	352	228
	(356)	(177)	(215)	(116)
Academic Performance Index (API)	702	673	580	611
	(99)	(99)	(84)	(92)
Fraction of Students Disadvantaged	22	29	50	39
	(19)	(23)	(25)	(26)
Fraction of Students Caucasian	51	49	32	40
	(25)	(25)	(25)	(28)
Fraction of Schools with AVID Program	35	42	41	45
	(48)	(50)	(49)	(50)
Total Schools	240	66	151	134

Panel A: 813 schools. Panel B: 591 schools. Standard Deviations are reported in parentheses

Table 1 shows that there were numerous schools that chose not to accept the grant even though they were eligible for funding. This creates a complication for estimation because one may assume that these schools estimated the cost of offering additional AP courses was higher than the benefit, even with the additional funding. If this is the case, including these schools in the control group may overestimate the effect of an additional course because schools with the lowest benefit opted out of the requirement to increase courses.

Compared to schools that were required to increase AP access due to the grant, schools that rejected the grant had only marginally less AP growth between 1999 and 2002, when the grant requirement was in effect. Schools that rejected the grant increased AP courses offered by 1.4 courses whereas the grantees that faced the requirement offered an additional 1.7 courses on average. Because schools that rejected the grant increased AP course access at a similar rate compared to the schools that accepted the grant, it is plausible that schools rejected the grant to avoid the other costs that were not associated with the requirement of increasing course access. While the reason for rejection is not certain, the demand for AP courses in schools that rejected the grant was sufficient enough to increase access without additional funding. As such, estimates should not be overstated by including these schools in the control group.[5]

Table 2 describes schools for the 1999-2000 school year, before the grant was allocated. Descriptive variables include the number of students attending the school and the a variable named "Enrollment in AP Courses". This variable is the total number of students in all AP courses, which implies that if a student is taking both AP Calculus and AP English, this student is counted twice. The data from the CDE do not report the number of AP classes taken by an individual student.

Also reported in Table 2 is the percentage of students in the school that are defined as socioeconomically disadvantaged and the percentage of students that are Caucasian. The Academic Performance Index (API) is reported, which is a statewide index of school performance based on standardized testing. Finally, Table 2 includes the use of a tutoring program called Advanced Via Individual Determination (AVID). This program was encouraged in conjunction with the AP Challenge Grant and is meant to provide additional tutoring and counseling to underprivileged students. I control for this program, as it could encourage additional participation in advanced courses.

Panel A of Table 2 reports statistics for all schools, divided into the categories already described. Between these designations, schools appear significantly different on observable statistics. This is not surprising, as schools with limited AP course offerings will tend to be disadvantaged and have lower demand for advanced coursework. Within the schools that received the grant, schools that were not required to increase the number of AP courses offered also tend to be larger and have a larger population of disadvantaged students. This should be expected, as these schools were eligible for the grant based on their disadvantaged status.

These differences are the core of the problem with the non-random treatment assignment in this analysis. Schools that were required to increase AP courses are different from non-grantees because they have lower demand for advanced courses, which could be caused by

[5] If schools that rejected the grant are excluded from the analysis, the magnitude and significance of the estimates are not significantly altered.

smaller school size or student ability. Controlling for these variables can account for some of these differences, but an additional identification strategy can alleviate a portion of the omitted variable bias caused by differences in demand.

Panel B of Table 2 reports the descriptive statistics for the sample of schools that offered at least four AP courses in the 1999-2000 school year. Within this subsample, the requirement to increase courses was due to the lack of an AP math or science course as opposed to a limited AP curriculum in general. This identification strategy makes it possible to compare schools that offered the same number of AP courses before the grant was allocated, but were required to increase AP courses because they did not offer a specific course.

Identifying the effect of an additional AP course based on AP math and science offerings eliminates some of the unobserved demand that may confound estimates. Evidence for this improvement is illustrated by the decrease in observed differences between treatment and control schools in Panel B of Table 2.[6] This subsample of schools is used to estimate the primary results of the analysis.

4. Empirical Model and Results

I use a difference-in-differences approach with instrumental variables to estimate the effect of an additional AP course on AP enrollment within a school. The time period of interest is between the 1999-2000 school year and the 2001-2002 school year, as these were the years that schools were under the requirement to increase courses. Therefore, each school in the sample has two observations: one observation in the 1999-2000 school year and one observation in the 2001-2002 school year.

Consider the following estimator that measures how a change in the number of AP courses offered in a high school affects AP enrollment:

$$APenroll_{it} = APoffer_{it} \cdot \beta_1 + year2002_t \cdot \beta_2 + X'_{it} \cdot \beta_3 + \gamma_i + \epsilon_{it}, \tag{1}$$

where $APenroll_{it}$ is the total enrollment in AP courses in school i at time t, $APoffer_{it}$ is the number of AP courses offered in a school and $year2002_t$ is a vector that equals one if the data are from the 2001-2002 school year. The variable X_{it} is a matrix of control variables that include school size in students, the academic performance index, the fraction of students that are disadvantaged, the fraction of students that are Caucasian and the use of the AVID tutoring program. The variable γ_i is a fixed effect for each school.

Specification (1) estimates the effect of offering an additional AP course on AP enrollment as β_1. The estimate for β_1 is reported in the first column of Table 3 as a significant increase of 35.9 students enrolled in AP courses for every additional AP course offered. The shortcoming of this estimate is that the decision to offer an additional course is correlated with demand for AP enrollment within the school. Therefore, the schools that offer additional courses are likely to experience growth in AP enrollment even without additional course offerings.

[6] Many of the observable variables are still significantly different between the treatment and control groups in Panel B of Table 3. Using smaller subsamples can eliminate differences between groups, but cause the sample size to shrink considerably. Analysis that uses stricter subsamples with observable characteristics that are not significantly different between the control and treatment groups yield results with similar implications.

In other words, the error term, ϵ_{it}, is correlated with the number of AP courses offered, $APoffer_{it}$, and this overestimates the effect of offering an additional AP course.

Table 3:
Effect of Additional AP Course Access on Total AP Enrollment

		First Stage	Second Stages	
	Total AP Enrollment	Total AP Courses	Total AP Enrollment	Total AP Enrollment
Independent Variable	(1)	(2)	(3)	(4)
AP Courses Offered	35.9***		10.7	3.91
	(5.39)		(14.8)	(15.8)
Requirement × 2001-2002		0.94***		
		(0.23)		
Grant × 2001-2002		-0.16	-5.95	-6.93
		(0.22)	(11.9)	(12.5)
2001-2002 School Year	-1.87	0.65***	24.6*	44.2***
	(10.6)	(0.14)	(13.4)	(16.0)
Total Students Enrolled	0.058**	0.001***	0.080***	
	(0.028)	(0.0004)	(0.030)	
Academic Performance Index	-0.13	-0.002	-0.15	
	(0.19)	(0.003)	(0.18)	
Fraction Disadvantaged	-62.0	-0.07	-60.5	
	(60.5)	(1.0)	(64.0)	
Fraction Caucasian	-6.06	0.7	1.37	
	(156)	(2.3)	(142)	
AVID	-15.3	0.49**	2.50	
	(13.5)	(0.18)	(13.9)	
Observations (2 × # Schools)	1,626	1,626	1,626	1,626
R^2	0.95	0.19	0.54	0.29
F-Statistic (First Stage)			5.52	10.52

*10%, **5%, ***1% Significance; Robust Standard Errors in parentheses. All regressions include school fixed effects.

This study proposes that the requirement to increase AP courses serves as an instrument for the change in the number of AP courses offered in a high school. A valid instrument will be correlated with the change in AP course offerings but be uncorrelated with the error term in the AP enrollment regression. The only way that the requirement to increase AP courses should affect enrollment is through the additional courses caused by the grant requirement. This is reasonable, except for the unobserved differences that may have affected both the assignment to the treatment and the demand for enrollment in AP courses.

A specification for a first stage predicts the change in the total number of AP courses offered in a school between 1999 and 2002 using the requirement of the grant:

$$\begin{aligned} APoffer_{it} &= requirement_i \times year2002_t \cdot \rho_1 + grant_i \times year2002_t \cdot \rho_2 + \\ &\quad year2002_t \cdot \rho_3 + X'_{it} \cdot \rho_4 + \gamma_i + \mu_{it}. \end{aligned} \tag{2}$$

Table 4:
Effect of Additional AP Math or Science Course on AP Enrollment

			First Stage	Second Stages	
	Total AP Enrollment	AP Math/Science Enrollment	AP Math/Science Courses	Total AP Enrollment	AP Math/Science Enrollment
Independent Variable	(1)	(2)	(3)	(4)	(5)
AP Math/Science Courses	59.5***	35.2***		15.3	26.7***
	(14.5)	(4.10)		(30.5)	(10.1)
Grant × 2001-2002			0.11	0.27	2.90
			(0.12)	(18.5)	(6.13)
Requirement × 2001-2002			0.63***		
			(0.13)		
2001-2002 School Year	14.4	-0.74	0.17**	29.9**	1.02
	(14.7)	(4.77)	(0.08)	(12.6)	(4.18)
Total Students Enrolled	0.055	0.014	0.0002	0.058	0.015
	(0.041)	(0.016)	(0.0002)	(0.037)	(0.012)
Academic Performance Index	-0.23	0.020	-0.002	-0.26	0.0015
	(0.29)	(0.13)	(0.002)	(0.27)	(0.091)
Fraction Disadvantaged	-33.3	0.78	-0.08	-37.7	-0.34
	(85.3)	(29.2)	(0.61)	(88.0)	(29.1)
Fraction Caucasian	133	10.6	0.22	119	11.9
	(263)	(103)	(1.50)	(214)	(70.8)
AVID	-10.3	-8.73	0.08	-1.17	-7.51
	(20.7)	(8.39)	(0.11)	(16.6)	(5.51)
Observations (2 × # Schools)	1,182	1,182	1,182	1,182	1,182
Adjusted R^2	0.93	0.95	0.89	0.21	0.55
F-Statistic (First Stage)				4.64	4.64

*10%, **5%, ***1% Significance; Robust Standard Errors in parentheses. All regressions include school fixed effects.

Specification (2) includes two variables that were not included in (1). First, $requirement_i$ is a vector that equals one if a school is required to increase courses over the time period. This term, interacted with the second time period indicator, serves as the instrument that is excluded in the second stage. Second, $grant_i$ is a vector that equals one if a school received the AP Challenge Grant, which is likely related to AP enrollment and also included in the second stage. The variables $requirement_i$ and $grant_i$ are interacted with the $year2002_t$ variable to measure the effect of the grant on the change between the two years. The variables are not included without the interaction because of collinearity with the school fixed effect.

In specification (2), the difference-in-differences estimator of interest is ρ_1. This coefficient is reported in column two of Table 3, along with estimates of the control variables. Schools that received the grant, as an entire group, did not offer significantly more AP courses between 1999 and 2002. Of the grantees that were required to increase courses, the number of AP courses offered increased by approximately 0.94 courses relative to other grantees. Adding the coefficients of ρ_1 and ρ_2 yields the difference between schools that were required to increase courses and schools that did not receive the grant. Because the magnitude of ρ_2 is small, the comparison with the schools that did not receive the grant is not significantly different than the comparison using other grantees.

The F-statistic on the first stage regression that tests the significance of the excluded instruments is only 5.52, which could be due to a small sample size or the inclusion of multiple control variables. When the first stage estimates are calculated without control variables, the significance of the $requirement_i$ interaction term is significant at the one percent level, the reported F-statistic is 10.52 and the implications of the results do not change. This fact, combined with the significance on the instrument in the specification that includes control variables, reduces the concern for weak instruments.

To find the effect of an exogenous increase in the number of AP courses offered in a school, the coefficients from the first stage are used to predict the number of AP courses offered at school in a given year, $\widehat{APoffer}_{it}$. In the second stage, enrollment in AP courses is regressed on the predicted number of AP courses and the covariates,

$$APenroll_{it} = \widehat{APoffer}_{it} \cdot \alpha_1 + grant_i \times year2002_t \cdot \alpha_2 + year2002_t \cdot \alpha_3 + X'_{it} \cdot \alpha_4 + \gamma_i + \sigma_{it}. \quad (3)$$

The coefficient α_1 is the effect of offering an additional AP course on enrollment in AP courses. The results from the second stage regression that includes covariates are reported in the third column of Table 3. Unlike the estimate in column one, these results indicate that an exogenous increase in the number of AP courses offered in a school has no significant effect on the number of students enrolled in AP courses. The growth in AP enrollment is predominantly explained by growth in school size. Column four reports a regression that does not include control variables and the implications from the analysis are unchanged, but the F-statistic is above the benchmark of 10.

One concern with the estimates in Table 3 is that the error term in specification (3) may be correlated with the instrument used in the first stage. This concern is legitimate because schools that offer less than three AP courses initially are those that have the lowest demand for AP courses. They are also those that will definitely be assigned the requirement to increase the number of AP courses offered. One solution to this problem is to compare schools that offered the same number of AP courses before the grant was allocated, but

were assigned the requirement based on the lack of an AP math or AP science course in the 1999-2000 school year. This identification strategy is superior because it implies that demand for AP courses as a whole were similar between the treatment and control groups. Demand or resources for AP math or AP science is what remains of the correlation between the error term and the instrument. If this correlation exists, it is likely to underestimate the effect on enrollment within those two specific subjects.

To compare schools based on this identification strategy, the schools that offered less than four AP courses in the 1999-2000 school year are omitted from the analysis. The results in the first column of Table 4 are estimated using specification (1) to measure the effect of changes in AP math and science course access on changes in total enrollment in AP courses. The results in the second column use the same specification to estimate the effect of AP math and science courses on enrollment in AP math and science courses specifically. Like the non-instrumental variable regression in Table 3, these columns indicate a strong correlation between the number of AP courses offered and AP enrollment.

The first stage regression that predicts the number of AP math and science courses in a school uses specification (2) but replaces the dependent variable with the number of AP math and science courses offered each year. Results in column three indicate that schools that were required to offer both an AP math and science course significantly increased AP courses in these subjects by 0.63 courses.

Column four of Table 4 reports the results from a regression of AP enrollment on the predicted number of AP math and science courses offered. The magnitude of the coefficient is larger than the coefficients reported in Table 3, but the implications are the same. There appears to be no significant increase in AP course enrollment when a school exogenously increases the number of AP courses offered.

The estimates in column five indicate the mechanism through which this insignificant result occurs. The specification used to calculate the estimates in column five regress the enrollment in AP math and science courses on the predicted number of AP math and science courses offered. Estimates indicate the total enrollment in math and science AP courses increase, with an additional 27 students enrolled in these subjects as a result of them being offered. The combination of the results in column four and five suggest that offering these courses clearly increases enrollment in the specific subjects, but it appears that students substituted math and science courses for other AP courses they would have otherwise taken.

Any potential endogeneity originating from low demand for AP math and science would negatively bias the coefficient for enrollment in math and science courses. The fact that the coefficient on enrollment in these subjects is positive and significant indicates that offering these courses did affect enrollment, but only as students substituted away from non-math and non-science AP courses. The combination of these actions results in a insignificant change in total AP enrollment.[7]

5. Conclusion

This paper exploits the requirement of a grant in California that required some schools

[7]Not included in this analysis is the number of AP exams taken in a school. There is no significant effect AP exam taking and in the interest of space, this analysis has been omitted but is available from the author.

to increase the number of AP courses offered to their students. To alleviate potential endogeneity, the effect is identified by comparing schools that offered the same number of AP courses before the grant was allocated, but faced different requirements based on the subjects of the AP courses offered. This analysis shows that offering an additional AP math or science course does increase enrollment in those subjects, but overall AP enrollment is not significantly altered. When AP math or science courses were offered, students substituted the new subjects for the AP courses they would have taken otherwise.

In this case, if the benefit of taking AP math or science outweighs the benefit of taking other AP course subjects, then requiring these core subjects may be beneficial. Because the students chose to enroll in these subjects, it implies that they believed the benefit was greater. Unfortunately, it is impossible to determine whether students chose to enroll in these courses independently or if school administration influenced their decision.

Overall, the results of this study indicate that offering additional AP courses in schools that do not offer them on their own will not increase total AP course enrollment. This outcome suggests that requiring additional advanced courses within a school will not likely provide students with significant benefits. Given this, it may be best to ensure that the advanced courses available within a school provide the highest possible benefit to students, instead of increasing the number of advanced subjects taught. Understanding the best way to provide access to advanced courses is an important topic for schools with limited resources and an interesting topic for further research.

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