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Research Notes

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Advanced Placement® Statistics Students' Education Choices After High School

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Introduction

The College Board's Advanced Placement® (AP®) Program was founded in 1955 as a national testing program with the goal of providing high school students opportunities to take college-level courses. As of the 2009 administration, the AP Program will consist of 37 courses in 20 different subject areas. Despite the tremendous growth of the program, the College Board has not been able to systematically track what happens to the exam-taking population after they are examined, nor has it any information on students who take an AP course, but not the corresponding AP Exam.

There is the expectation that students participating in the Advanced Placement Program tend to be more likely than nonparticipants to choose postsecondary course work that is related to the discipline in which they are examined, and there is some evidence supporting this claim (Morgan & Crone, 1993; Morgan & Maneckshana, 2000; Willingham & Morris, 1986). A series of studies evaluated the extent to which AP examinees continued studies in the AP Exam discipline at the postsecondary level. Both Willingham and Morris, who followed 1,115 students at nine postsecondary institutions, and Morgan and Crone, who analyzed data from first-year students in the University of California system, found that students taking AP Exams in a given discipline are more likely to have enrolled in postsecondary courses in that subject area than students not taking the exam.

Morgan and Maneckshana (2000) evaluated the number of same-discipline courses taken by students who took at least one of 28 AP Exams and found that for all but three exams (U.S. History, English Language and Composition, and English Literature and Composition), AP examinees were more likely than non-AP examinees to take courses in the discipline of the exam. While Morgan and Maneckshana did not analyze the relationship of AP Statistics participation and subsequent course taking, they did report a very robust finding across 25 exams and 21 colleges and universities.

One study that analyzed the more general relationship of high school mathematics and science course work with choice of a math or science major in college was Trusty (2002). Trusty estimated separate models for men and women, given previous findings of significant gender interaction effects. He found that even after controlling for racial/ethnic group, socioeconomic status, eighth-grade mathematics and science exam scores, and high school educational attitudes and behaviors, course-taking patterns in high school do have a significant relationship with choice of a math or science major.

Just as the empirical evidence above indicates, anecdotal evidence also suggests that AP Statistics examinees may be more likely to take college-level statistics courses than non-AP Statistics examinees. Mary Ellen Bock (2007), a past president of the American Statistical Association (ASA), wrote an article entitled "The Statistics Major." She noted her concern about the current lack of qualified master's and doctoral statisticians, but cited an encouraging trend reversal that she tied directly to participation in AP Statistics. She believes that exposure to statistics before matriculation to college or university leads to an awareness of and enthusiasm for the statistical sciences.

Purpose

In order to explore the relationship between AP Statistics exposure and educational outcome, which is of great interest to the College Board and the ASA, the two organizations collaborated on a survey of past AP Statistics examinees. Among the stated goals of this survey was to evaluate the relationship of the participation in AP Statistics to continuation of statistical study in a postsecondary setting. Of the 19 questions asked in the survey, those that related to the rationale of taking both AP Statistics and college-level statistics follow:

- How important were each of the following reasons for why you took AP Statistics in high school? (See Table 1 for the list of response options.)
- How did your exposure to the AP Statistics course material affect your interest in statistics?
- Did you take any statistics courses in college? Depending upon the individual's response, he or she was asked one of the following questions:
  - How important were each of the following reasons that you took that first statistics course? (See Table 4 for the list of response options.)
  - How important were each of the following reasons why you did not take any statistics courses in college? (See Table 5 for the list of response options.)
- How did your exposure to the first statistics course in college affect your interest in statistics?
- Did you take any additional statistics courses in college beyond that first statistics course?
- What is or was your [undergraduate] major in college?

For the three "importance" questions, respondents were asked to rate the importance of each reason on a scale of one to five, with one being "not at all important" and five being "extremely important"; no interim values were labeled. When rating the extent to which exposure to either AP Statistics or respondents' first college course in statistics affected interest in statistics, the response options were: "greatly decreased"; "somewhat decreased"; "no effect"; "somewhat increased"; and "greatly increased."

Other survey items were related to credit- and placement-granting policies of colleges and universities, students' choice of major, and the extent to which respondents' current job involves the application and interpretation of statistics. These questions were not included in this analysis because some were not relevant to the immediate goals of this survey, and others — like the one relating to employment — had such small response rates.

Method

Sampling Plan and Results

This work began in the summer of 2005, and in order to identify a range of past examinees, from those who may currently be enrolled in college or university to those who have completed their postsecondary study and have begun careers, the sample was drawn from all AP Statistics examinees from the 1997 through the 2003 administrations who lived in the United States at the time of examination. The factors that were directly controlled for when designing the sampling scheme included year of examination, exam grade, gender, and the six U.S. regions defined by the College Board. One important note is that students who took the AP Statistics course in their high school but did not subsequently take the AP Statistics Examination were not included in the sample because the contact information for these students was not available.

The final sample of 2,143 examinees was drawn from the nearly 230,000 AP Statistics examinees in the sampling frame. At the end of the data collection period, 408 respondents returned the questionnaire — 177 by mail and 231 via the Web — which yielded a response rate of 19 percent and, after accounting for a total of 442 undeliverable packages and refusals, a completion rate of 24 percent. See the Appendix for more detailed information on the population, sample sizes and response rates.

Statistical Corrections

In order to reduce bias and improve precision, the figures presented in the results section of this paper have been corrected for two important phenomena. The first phenomenon for which the figures were corrected was the fact that not all past examinees who were eligible for inclusion in the sample were equally likely to be selected. For example, because the author was interested in controlling for the differences in survey responses across years, a proportionally larger number of past examinees from the early years of the relevant period were drawn (see Appendix). The expectation was that it would be more difficult to reach these individuals because the addresses on record were from the time of the AP Examination, which could be as many as eight years old. For that reason, the response data were corrected for selection probability or the chance that each individual from the nearly 230,000 AP examinee population would be chosen as one of the 2,143 sampled individuals.

The second important phenomenon for which the figures to follow were corrected was survey (or unit) nonresponse. Some of the sampled individuals were more likely to respond to the survey than others in the sample. Indeed, the Appendix shows that response rates were substantially higher for females, generally appear to be higher for individuals receiving higher AP Statistics Exam grades, and may differ slightly by U.S. region. The College Board has demographic and exam performance data for all examinees, and therefore can use these data to estimate the chance that each sampled individual would respond to the survey. Consider the individuals who were very likely to respond when they received the survey (e.g., high-scoring females in later testing years); they may be fundamentally different in terms of their survey responses than those who are inherently unlikely to respond (e.g., low-scoring males in earlier testing years). The unadjusted approach that ignores this fact would result in figures that overrepresent the subpopulation that was likely to respond, and hence potentially would introduce a bias in the final figures. It is for this reason that the figures were corrected for survey nonresponse.

Ignoring these differences in sample selection and response probability would likely result in biased results, and when the unadjusted analyses were run, they typically differed substantially from what is presented below. For example, assuming that applying these two corrections results in approximately unbiased estimates, the unadjusted approach overestimates the proportion of students who indicated a greatly or somewhat increased interest in statistics as a response to exposure to the AP Statistics course, and underestimates the proportion of students whose interest greatly or somewhat decreased. Because the response rates are higher for those students who performed well on the AP Statistics Exam (see Appendix) and it is reasonable to expect that the changed interest in statistics is related to students' performance, it seems appropriate to apply the correction for nonresponse. In other words, the evidence suggests that there is support for both of these corrections.

The percentage estimates, standard errors and 95 percent confidence intervals are presented for each item and response category for each analysis. Because of the corrections described above, it is appropriate to consider these results as representative of the entire population of approximately 230,000 examinees. The full results of the analyses of the seven items are presented in Tables 1–7.

Results

Tables 1–7 are presented in the order that most appropriately captures the order in which students' educational choices are made. First, the analysis of individuals' most important reasons for taking the AP Statistics class is presented in Table 1. Respondents were asked to rate on a scale of one to five the importance of each reason in making the decision to take AP Statistics. The reasons that stand out as being different from the mean importance value of 2.89 are the four response values whose 95 percent confidence limits do not overlap with the overall mean importance for this item. In particular, the two responses that are associated with greater importance are that the student was interested in mathematics and the "other reasons" category. The two values that are significantly less important than the mean importance level are that the student was thinking of majoring in mathematics or statistics and that the student's high school offered few AP courses, of which AP Statistics was one. These results, taken together, indicated that AP Statistics students' main reason for choosing to take the course was that they were generally interested in mathematics, but not enough to consider majoring in mathematics or statistics in college; and they did not simply take AP Statistics because they had few other courses from which to choose. This is reasonable because students were more likely to have been more heavily exposed to mathematics than to statistics, and as such their preferences for mathematics were likely to be more well-formed than for statistics.

When asked how exposure to the AP Statistics course material affected their interest in statistics, 40.0 percent of respondents indicated that exposure somewhat increased their interest, and 13.8 percent indicated that it greatly increased their interest (see Table 2). This is encouraging, especially given that students generally stated that interest in statistics was neither important nor unimportant in their decision to take AP Statistics in the first place.

The next major decision that students make with respect to their statistical education is of course whether to take any college or university courses in the discipline. Table 3 shows that 59.3 percent of AP Statistics examinees went on to take further courses in statistics. Table 4 shows the relative importance that students choosing to continue their studies of statistics placed on various reasons to continue. Overwhelmingly, students indicated that the fact that statistics was required for their major was the reason they took their first statistics course. Another reason that was of significantly greater importance than the mean importance for all response values was that students felt confident that

they could do well in the course. Interestingly, while they indicated that feeling confident they would perform well was an important reason, they also indicated that thinking it would be an easy course was decidedly less important. This finding supports the argument that upon completion of the AP Statistics course, students' most important reason for taking statistics was that it was required, but feeling competent to take on course work in statistics at the college level also weighed heavily in their decision. It is important to note that being interested in statistics seems to be less important in the decision-making process, perhaps outweighed by the "requirement" and "confidence" options that differ more substantially from the mean importance level for this item.

Both of these findings were supported by the similar question asked of students who did not take any college-level statistics courses. Those individuals were asked to rate the importance of a number of reasons in their choice not to take any future courses in statistics, and the factor that was greatest was that it was not required for their degree, as shown in Table 5. Two other relatively important, statistically significant reasons for not taking further course work were that AP Statistics fulfilled all degree requirements and that the student was not interested in statistics. These students also reported that their decision not to take the course was not affected very much by either fear that they would not do well in a statistics course or by their thinking that it would be a difficult course to take. These results complement the inferences made from the reasons given by students who did take the course. The choice to take further course work in statistics seems to be closely related to students' major requirements, and AP Statistics students' confidence in their mastery of statistics does not seem to be a factor in their decision.

Those students who did take at least one college course in statistics were asked how that exposure to statistics affected their interest in statistics, just as each respondent was asked how exposure through the AP Statistics course affected their interest in the subject matter. Table 6 shows that more than half of the students indicated that their first college course in statistics had no effect on their interest in studying statistics, with 34.9 percent indicating that the first course either somewhat or greatly increased their interest in statistics. Given the relatively few respondents, it is difficult to simultaneously compare individuals' reported effects of AP Statistics and the first college course in statistics, respectively, on their interest in statistics. It is also difficult to interpret this result because there was no control group of college students who were not exposed to AP Statistics, but who did take at least one college course in statistics. Comparisons to such a control group would make these results more meaningful and put them in better context.

Finally, for completeness, Table 7 reports the estimated percentages of the AP Statistics Exam-taking population by their undergraduate college major. The apparently small percentage of students reporting a major in either statistics, mathematics with a concentration in statistics, or simply mathematics is 7.3 percent, but when compared with the cohort of undergraduate students enrolled in the 2003-04 academic year at four-year institutions, of whom only 0.7 percent majored in mathematics or statistics (Snyder, Dillow, & Hoffman, 2008, pp. 320–321) the difference is quite substantial. Indeed, this may be an artifact of the population (i.e, AP Statistics examinees) having a greater underlying interest in the quantitative disciplines, and this comparison should not be taken as a causal implication that AP Statistics causes a greater tendency to major in statistics.

Limitations and Opportunity for Future Research

This analysis was limited in two related ways: the sample drawn was from AP Statistics examinees and there was no comparison group that was asked comparable questions. The pool of possible individuals who could have been included in the sample only includes students who took the AP Statistics Exam, rather than the larger population who took the course or who took any high school statistics course, or perhaps all students, depending upon the desired inference. Since there is no central database of all students who took the AP Statistics course, future researchers who aim to correct this issue will develop a reliable and cost-effective method of identifying all AP Statistics course-takers. Since an alternate version of the survey was not also administered to a comparison group of individuals not exposed to AP Statistics, it is difficult to make comparisons and impossible to draw causal inferences. Such an additional survey would enable future researchers to make statements such as "AP Statistics examinees are a certain number of times as likely as non-AP Statistics examinees to take statistics courses in college." Finally, another potentially important and more elaborate project could track students and their attitudes and motivations before and immediately after exposure to AP Statistics,

and then follow up with a survey of the kind performed here. This would result in more accurate data on the motivations of students for taking the course, rather than the post hoc design implemented here that may have suffered from individuals failing to accurately remember motivations for the choices made with respect to statistics education.

Conclusion

The results from this survey do seem to support at least one claim that Bock made in the article cited above: taking the AP Statistics course and exam does appear to be related to greater interest in the statistical sciences. Despite this finding, with respect to deciding whether to take further statistics course work and majoring in statistics, students appear to feel prepared for, but not interested in, further study. There is certainly more research needed in order to make causal inferences about the issues presented in this analysis. However, it should serve as encouragement for both AP Statistics and college statistics instructors and the broader statistical community that the AP Statistics program seems to be successful in preparing students for further study and in increasing interest in statistics. It may not, however, affect students' choice to pursue statistics as a major.

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Table 1 Analysis of Survey Item #2

"How important were each of the following reasons for why you took AP Statistics in high school?"

Reason	*Estimate of Mean Importance**	*Standard Error of Mean Importance*	*95% Confidence Limits for Mean Importance*	
			Lower	*Upper*
(a)	(b)	(c)	(d)	(e)
You were interested in statistics	3.06	0.05	2.96	3.17
You were interested in mathematics	3.27 †	0.06	3.16	3.38
You were thinking of studying mathematics or statistics in college	2.48 †	0.07	2.35	2.61
A teacher suggested you take AP Statistics	2.78	0.08	2.63	2.93
The course fit into your class schedule	2.95	0.06	2.82	3.08
Your high school offered a limited number of AP courses, and AP Statistics was one of them	2.45 †	0.07	2.31	2.60
AP Statistics would improve your chances for admission to college	3.09	0.08	2.94	3.24
Other reasons	3.37 †	0.16	3.05	3.70
Mean Importance of All Responses	2.89	0.04	2.81	2.98

* Responents were asked to rate the importance of each reason on a scale of one to five, with one being "not at all important" and five being "extremely important." No interim values were labeled.

† Significantly different from the mean importance of all responses for this item at a 95 percent confidence level.

Source: The College Board

Note: Estimates have been corrected for (1) sample selection probability and (2) unit nonresponse probability.

Table 2 Analysis of Survey Item #3

"How did your exposure to the AP Statistics course material affect your interest in statistics?"

Response Value	*Estimate of Percent*	*Standard Error of Percent*	*95% Confidence Limits*	
			Lower	*Upper*
(a)	(b)	(c)	(d)	(e)
Greatly Decreased	13.8%	0.82	12.2%	15.4%
Somewhat Decreased	7.5%	1.17	5.2%	9.8%
No Effect	24.9%	1.63	21.7%	28.1%
Somewhat Increased	40.0%	2.22	35.7%	44.4%
Greatly Increased	13.8%	1.41	11.0%	16.6%

Source: The College Board

Note: Estimates have been corrected for (1) sample selection probability and (2) unit nonresponse probability.

Table 3 Analysis of Survey Item #4

"Did you take any statistics courses in college?"

Response Value	*Estimate of Percent*	*Standard Error of Percent*	*95% Confidence Limits*	
			Lower	*Upper*
(a)	(b)	(c)	(d)	(e)
Yes	59.3%	2.42	54.5%	64.1%
No	39.9%	2.40	35.1%	44.6%

Source: The College Board

Note: Estimates have been corrected for (1) sample selection probability and (2) unit nonresponse probability.

Table 4 Analysis of Survey Item #8

"How important were each of the following reasons that you took that first [college/university] statistics course?"

Reason	*Estimate of Mean Importance**	*Standard Error of Mean Importance*	*95% Confidence Limits for Mean Importance*	
			Lower	*Upper*
(a)	(b)	(c)	(d)	(e)
It was required for your degree or major	4.55 †	0.04	4.47	4.63
You were interested in statistics	2.88 †	0.07	2.75	3.02
You felt confident you could do well in that course	3.64 †	0.06	3.52	3.76
You thought it would be an easy course to take	2.73 †	0.12	2.49	2.97
Other reasons	1.58 †	0.02	1.53	1.63
Mean Importance of All Responses	3.32	0.05	3.22	3.43

* Responents were asked to rate the importance of each reason on a scale of one to five, with one being "not at all important" and five being "extremely important." No interim values were labeled.

† Significantly different from the mean importance of all responses for this item at a 95 percent confidence level.

Source: The College Board

Note: Estimates have been corrected for (1) sample selection probability and (2) unit nonresponse probability.

Table 5 Analysis of Survey Item #5

"How important were each of the following reasons why you did not take any statistics courses in college?"

Reason	*Estimate of Mean Importance**	*Standard Error of Mean Importance*	*95% Confidence Limits for Mean Importance*	
			Lower	*Upper*
(a)	(b)	(c)	(d)	(e)
It was not required for my degree	3.79 †	0.03	3.72	3.86
AP Statistics credit satisfied all statistics requirements for the degree	2.55 †	0.05	2.44	2.65
Was not interested in statistics	2.82 †	0.04	2.73	2.90
Was afraid I would not do well in a statistics course	1.30 †	0.01	1.28	1.32
Thought it would be a difficult course to take	1.37 †	0.02	1.32	1.42
Other reasons	2.73	0.25	2.10	3.37
Mean Importance of All Responses	2.40	0.02	2.36	2.43

* Responents were asked to rate the importance of each reason on a scale of one to five, with one being "not at all important" and five being "extremely important." No interim values were labeled.

† Significantly different from the mean importance of all responses for this item at a 95 percent confidence level.

Source: The College Board

Note: Estimates have been corrected for (1) sample selection probability and (2) unit nonresponse probability.

Table 6 Analysis of Survey Item #9

"How did your exposure to the first statistics course in college affect your interest in statistics?"

Response Value	*Estimate of Percent*	*Standard Error of Percent*	*95% Confidence Limits*	
			Lower	*Upper*
(a)	(b)	(c)	(d)	(e)
Greatly Decreased	7.8%	1.59	4.6%	11.0%
Somewhat Decreased	5.7%	1.34	3.1%	8.4%
No Effect	51.5%	3.51	44.6%	58.5%
Somewhat Increased	25.4%	2.54	20.3%	30.5%
Greatly Increased	9.5%	3.05	3.4%	15.6%

Source: The College Board
Note: Estimates have been corrected for (1) sample selection probability and (2) unit nonresponse probability.

Table 7 Analysis of Survey Item #14

"What is or was your major in college?"

Response Value	*Estimate of Percent*	*Standard Error of Percent*	*95% Confidence Limits*	
			Lower	*Upper*
(a)	(b)	(c)	(d)	(e)
Statistics	1.3%	0.7	0.0%	2.7%
Mathematics with a concentration in Statistics	0.4%	0.1	0.1%	0.7%
Mathematics	5.6%	1.1	3.5%	7.7%
Engineering or Computer Science	10.0%	1.1	7.9%	12.1%
Biology, Chemistry, Health Sciences, Physics, or other Natural Science	15.6%	2.0	11.6%	19.6%
Economics or Business	17.5%	1.7	14.2%	20.9%
Education	4.9%	0.6	3.7%	6.0%
Political Science, Psychology, Sociology, or other Social Science	23.0%	2.1	18.9%	27.1%
Agriculture	0.2%	0.2	0.0%	0.6%
Not Yet Decided	0.7%	0.5	0.0%	1.7%
Other	20.8%	1.4	18.0%	23.6%

Source: The College Board
Note: Estimates have been corrected for (1) sample selection probability and (2) unit nonresponse probability.

Appendix: Summary of Population and Sample Sizes and Response Counts by Strata Variables

Strata Variable	*Strata Variable Value*	*Population Size*	*Sample Size*	*Sampling Rate*	*Number of Respondents*	*Response Rate*
(a)	(b)	(c)	(d)	(e)	(f)	(g)
AP Exam Year	1997	7,551	372	4.9%	71	19.1%
	1998	15,222	344	2.3%	59	17.2%
	1999	24,805	323	1.3%	60	18.6%
	2000	33,651	302	0.9%	49	16.2%
	2001	41,034	280	0.7%	66	23.6%
	2002	49,241	257	0.5%	53	20.6%
	2003	57,496	232	0.4%	50	21.6%
AP Exam Grade	1	49,968	129	0.3%	12	9.3%
	2	44,911	132	0.3%	20	15.2%
	3	56,723	583	1.0%	121	20.8%
	4	50,402	589	1.2%	100	17.0%
	5	26,996	677	2.5%	155	22.9%
Gender	Male	113,089	1,056	0.9%	250	23.7%
	Female	115,911	1,054	0.9%	158	15.0%
U. S. Region*	MRO	32,417	352	1.1%	61	17.3%
	MSRO	44,794	352	0.8%	76	21.6%
	NERO	12,533	352	2.8%	61	17.3%
	SRO	61,218	353	0.6%	72	20.4%
	SWRO	17,934	352	2.0%	59	16.8%
	WRO	61,104	349	0.6%	79	22.6%
Overall	n/a	229,000	2,110	0.9%	408	19.3%

Source: The College Board

*The codes for U.S. regions are as follows:

MRO = Midwest
MSRO = Middle States
NERO = New England
SRO = Southern
SWRO = Southwestern
WRO = Western

n/a: Not applicable

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