
AC 2012-4723: DO HIGH SCHOOL COMPUTER AND AP COURSES AND SAT TEST SCORES HELP STUDENTS CHOOSE STEM MAJORS IN COLLEGE?

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**Do High School Computer and AP Courses, and SAT Test Scores
Help Students Choose STEM Majors In College?**

Abstract

A quantitative case study design was employed to investigate the relationships between students' computer and Advanced Placement (AP) course taking, SAT test scores, and their STEM major selection. Study data were collected through an online survey from a multi-school charter school system in which variety of computer courses are offered to 9-12 grade students. The study showed that students' SAT reading, composite (math + reading), and total scores had statistically significant relationship with students' STEM major choice. Even though there was not a statistically significant relationship between students' SAT math scores, there was a pattern showing that students with higher SAT math scores were more inclined to choose a STEM major. We also found that there was a statistically significant relationship between the number of students' AP science and AP courses and their STEM major selections. The last analysis revealed that there was no statistically significant difference between those but we found that those who chose STEM majors took more computer courses than those who did not choose to do so.

Introduction

The need for a larger workforce in Science, Technology, Engineering, and Mathematics [STEM] fields to stay competitive with other nations requires involvement of women and other underrepresented groups.⁶ Although more women have chosen the science and engineering fields as a career over the last decades, the proportion of women workforce in the science and engineering fields increased from 12% to 27% in the period of 1980 to 2007, they are still underrepresented.¹⁷ There are many reasons underlying the career choices of students such as the courses that have been taken during the secondary education.

Career selection is one of the most important choices that affect students' future lives (Borchert, 2002). Therefore, choosing a career pathway for many adolescents is not an easy process. A body of literature indicates that there are several factors influencing this decision making process, including: (1) The context in which students live, (2) the culture that they have been brought up with, (3) their aptitudes, (4) attitudes of other people (i.e. parents, teachers, counselor, etc.), (5) past experiences, (6) gender differences, and (7) educational attainment.^{2,3,8,9,15} Also, researchers found that the cognitive abilities of different genders mirror to the course enrollments of different genders.¹³ Because educational attainment somehow is affected by all other factors,²⁶ our focus in this study is on educational attainment.

A good indicator of a good educational attainment in USA is Advance Placement (AP) courses covering 31 different subjects. Researchers, who used different test scores (i.e. Scholastic Aptitude Test (SAT)), found that students who took more college preparatory math and science classes in high school had very high scores on these college entrance exams.^{5,14} From this perspective we may assume that taking AP courses during the high school years affect on the students' educational attainment and hence career choices.

Advanced Placement Courses and Major Selection

The Advanced Placement [AP] Program was created by the U.S. College Board in 1955 with the motto *Connecting Students to College Success*. The AP program aims to prepare students for an academically demanding college experience. Advanced Placement is a curricular option for academically superior high school students. “Naturally, courses offered in the program are more demanding in terms of time and intellectual skills than corresponding courses in the regular high school curriculum”.¹⁹ Initially, AP courses began as a program for elite private school students to take college-level course while still in high school. This way, outstanding students could begin college with already earned credits needed for freshman year, which potentially would help them graduate college earlier.

According to the recent data released in 7th AP Report to the Nation, the number of seniors taking at least one AP course and scoring 3 or more on AP exams has increased significantly.⁷(see Table 1) The increases are due to growing awareness of the program and variety of benefits of taking AP courses, and the significant role of AP courses in the college admission process.²⁰ Moreover, the No Child Left Behind Act²⁹ offers states substantial federal funding, \$24 million annually, to expand AP program in underserved populations.

Table 1. *More students are succeeding on AP exams today than took exams in 2001*

Year the exam was given	Number of seniors leaving high school having taken an AP Exam	Number of seniors scoring 3+ on an AP exam any point in high school
2001	432,343	277,865
2006	646,310	403,150
2009	797,629	478,973
2010	853,314	508,818

Some studies looked at the relationship between student AP takings and their career choices. In an earlier study, a group of researchers found that students who take AP physics classes during their high school years more lean towards STEM majors than non-physics taking students in high school.²¹ Robinson²² conducted a follow-up study to investigate how enrollment in AP Science and Calculus classes correlated with students STEM career choices. In addition, Robinson looked at students’ gender, ethnicity, and socio economic status to see if there is any difference in terms of STEM career majoring. He found that students, both minority and non-minority, who took AP calculus and science classes are more likely to pursue in majors such as science, engineering, mathematics, and the medical field.

SAT Courses

The Scholastic Aptitude Test (SAT) is a useful indicator of how students will do in college.⁷ In other words, SAT score is a concrete form of educational attainment for admission; therefore, it is one of the major determiners of which college major students will choose.¹⁰ The SAT measures students in three different areas, mathematics, critical reading, and writing. Scores can be between 600 and 2400, a maximum of 800-point from each section. Students from 9th grade to 12th grade can take the SAT. College board expresses that a combination of SAT scores and high school grade point average (GPA) can be a good predictor of students' success in college.⁷ In addition, some researchers found that students who are successful on math in high school and the SAT most likely prefer scientific majors to nonscientific majors.^{1,23,25}

This study aims to investigate whether students' high school computer and AP course taking and SAT test scores help them pursue in STEM majors. We specifically considered the relationships between student enrollment to computer, AP mathematics, AP science, AP social studies, and student SAT math, reading, composite (math+reading) and total scores and their major choice. So far the studies have examined the impact of undergraduates' course selection on their career choice.^{18,24} Yet, this study uses high school students' computer and AP course enrollments and SAT test scores data to study their affect on students' STEM major selection.

Research questions are as follows:

1. Are there a significant difference between students' SAT reading, mathematics, composite (math + reading), and total scores and their STEM major choices?
2. Is there a significant difference between students' # of AP science, # of AP mathematics, # of AP social studies, and # of AP course enrollments and their STEM Major choices?
3. Is there a significant difference between students' # of Computer course takings and their STEM major choices?

Method

Setting: Harmony Public Schools [HPS]

Harmony Public Schools are open-enrollment charter schools. Charter schools are a type of public school generally defined as a publicly funded, nonsectarian school that operates under a written contract, or charter, from an authorizing agency such a local or state board".²⁷ Charter schools are funded by the state but run independently in the sense that they have to hire their own teachers and staff, and manage their own budget. According to the TEA,²⁸ open-enrollment charter schools, like HPS, receive state funds based on the average daily attendance of students, just like independent school districts

As of 2005, Texas is among the top five states with the most charter schools in operation. Texas law passed legislation in 1995 for charter schools. According to the Texas Association of School Boards,²⁷ the number of Texas open enrollment charter schools is limited to 215. But charter schools may open charter campuses and operate as a network of charter campuses in a specific region or throughout the state.

HPS have located in Houston, Dallas, San Antonio, Austin, Fort-Worth, and El-Paso as well as in smaller cities including College Station/Bryan, Waco, Beaumont, Lubbock, Laredo, Brownsville, Odessa, Grand Prairie, Garland, Carrollton, and Euless. The HPS are college preparatory schools.¹¹ Only 11 % of all charter schools in Texas fall into the college preparatory classification. HPS, operated by the Houston-based nonprofit organization Cosmos Foundation, are college preparatory schools for K-12 graders.¹⁶ As of Dec 19, 2011, there are 36 campuses all over the state and serving more than 20,000 students.

The Texas Harmony charter school system's mission is "to prepare students for higher learning in a safe, caring, and collaborative atmosphere through a quality learner-centered educational program with a strong emphasis on mathematics, science, engineering, and technology".¹¹ Harmony students are predominately female (51%), Hispanic (47%), and low SES (56% free or reduced cost lunch).

Course offerings at HPS.

Texas provides three types of graduation plan: (1) Minimum (2) Recommended Graduation Plan, and (3) Distinguished Graduation Plan. HPS do not offer to their students to graduate with Minimum graduation plan because it only requires students to complete 22 credits in four-year and they only need to take 3 years science, 3 years mathematics, 3 years social studies, and 3 years English as opposed to taking 4 from each core subject. They say that this is against to their mission in which they promise to prepare students "... with a strong emphasis on math, engineering, science and technology" (HPS, p.1). Harmony Public Schools also offers variety of computer and technology courses to realize their mission.

We contacted HPS's central office administrator via phone to obtain consent in order to conduct the current study. After receiving the permission, we were provided with eight high school counselors' email addresses and phone numbers. The first author of the study contacted them by email and phone. Finally, we used Google document to collect the data from the participants between July 1st and August 30th, 2011.

We specifically focused on a charter school system because of their a) STEM focus (some of the campuses were categorized as STEM academies), b) Convenient location ., and (c) Harmony Public Schools offer variety of computer courses to their 9-12 grade students: Desktop publishing, Web Mastering, Digital Graphics and Animation, Video Editing, Game Design, AP Computer Science and such.

This study examined the data collected for graduates of HPS' class of 2011. Data were collected from a charter school organization in which eight of their campuses gave graduates during 2010-2011 year. We conducted a survey to collect their graduation status, demographic information (gender, ethnicity, and lunch status related to socio-economic level), major choices, SAT scores (if they took), and AP course enrollment. Out of 149 graduates, 126 of them provided their AP and SAT information. All 149 students' demographics, graduation status, and STEM major choices were provided.

149 seniors from the Texas-based HPS charter school system participated the study. Table 2 summarizes the demographics of the participants as follows:

Table 2. *Demographics of Students*

#Students	%Male	%Female	%Hispanic	%Black	%White	%Asian	%Econ Disadv
149	48	52	52	6	21	17	65

Out of 149 seniors, 77 of them were female, 78 of were Hispanics, 9 of them were Blacks, and 32 of them were Whites. 65 % (97) of all students received either free or reduced lunch.

Analyses

Before we started analyzing our data, we categorized student majors as STEM (0) and non-STEM (1) majors, and undecided (2) according to the U.S. Immigration and Customs Enforcement’s STEM-designated degree program list.³⁰ The program list included 328 majors as STEM majors.

Data were analyzed using SPSS. We used cross-tabs and chi-square analyses to examine the relationship between AP enrollments, computer course enrollments, SAT reading, mathematics,, and total scores and post-secondary major selection. We reported descriptive statistics to identify the matriculation data by students, majors, and demographics.

Table 3. *Demographics by matriculation*

	%Male	%Female	%Hispanic	%Black	%White	%Econ Disadv	#All	%All
4-year	96	91	92	100	88	96	139	93
2-year	4	9	8	0	13	4	10	7
STEM Majors	54	38	36	78	56	47	68	46

Findings

The purpose of the study was to investigate whether there is any pattern between high school graduates’ AP and computer course enrollments, SAT scores, and their major selection. Initial analyses showed that Harmony Public Schools’ all graduates graduated from their high schools and were admitted to a non-secondary institution. 96 % of males, 91 % females, 92 % of Hispanics, 100 % African Americans, 88% of Whites, and 96 % of economically disadvantaged students were admitted to a 4-year college. Among those, 54 % males, 38 % of females, 36 % of Hispanics, 78 % of African Americans, 56 % of Whites, and 47 % of economically disadvantaged students reported that they selected STEM majors to study at colleges.

The first research question investigates whether there is a significant relationship between SAT readings, SAT mathematics, SAT composite (math + reading), and SAT total scores and students' STEM major preference. The chi-square test results showed that there is a significant relationship between students SAT reading scores and their major choice (see Table 4.). Even though students with higher (>500) SAT reading scores chose more STEM majors, this difference was not significant (32 students chose STEM majors with higher scores, and 28 with lower scores) (see Table 4.). Also it was interesting to see that students with higher (> 500) SAT reading scores (only 8 students) were less hesitant about what they wanted to do when they graduated from their high schools than those with low (<500) scores (25 students) (see Table 4.).

On the other hand, there was not a significant relationship between students' SAT mathematics scores and their major preferences (see Table 4.). Nevertheless, it was clear that students with higher (>500) SAT mathematics scores (44) chose STEM much more often than students with lower SAT mathematics scores (18). This was an expected finding because students with good math knowledge are more likely to prefer engineering, computer science, mathematics, and science majors than less quantitative majors.

Table 4. *Chi-Square Test Results for STEM Major Choice by SAT Reading, Mathematics, Composite, and Total Scores*

		STEM Major Choice*			Total	χ ²
		0	1	2		
SAT Reading-Score**	1	12	28	25	65	χ ² (2)=15.98, p<. 05.
	2	21	32	8	61	
Total		33	60	33	33	
SAT Math-Score	1	9	16	12	37	χ ² (2)=1.06, p>.05.
	2	24	44	21	89	
Total		33	60	33	126	
SAT Composite-Score***	1	8	17	18	43	χ ² (2)=8.45, p<. 05.
	2	25	43	15	83	
Total		33	60	33	126	
SAT Total-Score****	1	9	22	21	52	χ ² (2)=10.00, p<. 05.
	2	24	38	12	74	
Total		33	60	33	126	

- 0=non-STEM majors, 1=STEM majors, 2=Undecided.
- ** 1= SAT scores less than or equal to 500, 2=greater than 500 and less than or equal to 800.
- *** 1= SAT scores less than 1000, 2= greater than 1000 and less than or equal to 1600.
- **** 1= SAT scores less than 1500 hundreds, 2= greater than 1500 and less than or equal to 2400.

Looking at the relationship of students SAT composite scores with their college major choice selection, we found a significant relationship between students with higher composite scores (43 students, reading + mathematics scores >1000) and their STEM major choice (see Table 4.). Strong math and reading scores are powerful indicators for to be in 21st century professions.¹²

We also looked at the relationship between students overall scores and their choice of college major. We found that students with higher total scores (38 students, >1500) chose STEM majors more than those with lower total scores (22 students, \pm 1500) (see Table 4.). The number of students choosing non-STEM majors or undecided (24+12) was lower than the number of students choosing STEM majors (38) in terms of SAT total scores (see Table 4.). This may indicate that students of higher caliber were more focused and inclined to choose STEM majors than other groups of students of lower scores.

We broke SAT scores into two groups <500 and >500 because chi-square test results came out meaningful when we used only two groups for individual SAT reading, and SAT Math scores. Similar grouping was also used for composite, and total SAT scores.

The second research question considers the relationship between STEM major and the number of AP mathematics, number of AP science, number of AP social studies, and number of total AP course enrollments. The chi-square analysis showed that there was not a significant relationship between students' number of AP mathematics enrollment and their STEM major selection (see Table 5.). In fact, more students with no AP mathematics course (39) chose STEM majors more often than those with 1 (17) or 2 (7) AP mathematics course enrollments respectively. In other words, taking AP mathematics courses does not guarantee students' STEM major preference. Similarly, although there was a significant relationship between students # of AP science course taking and their STEM program choice, this was not a guaranteeing factor for a student to choose a STEM major (see Table 4.) because number of students with 0 AP science courses (31), 1 AP science course (23), and 2 AP science courses (12) were almost same in terms of STEM major selection (see Table 5.).

Table 5. *Chi-Square Test Results for STEM Major Choice by # and Types of AP and Computer Course Enrollments*

		STEM Major Choice*				Total	²
		0	1	2			
# of AP-Math Courses	0	24	39	30	93	² (4)=2.80, p>. 05.	
	1	9	17	7	33		
	2	6	7	3	16		
Total		39	63	40	142		
# of AP-Science Courses	0	23	31	25	79	² (4)=13.74, p<.05.	
	1	16	23	11	50		
	2	0	12	1	13		
Total		39	66	37	142		
# of AP-Social Studies Courses	0	11	31	28	70	² (6)=21.67, p<. 05.	
	1	18	16	6	40		
	2	5	12	3	20		
	3	5	7	0	12		
Total		39	66	37	142		
# Of Total AP Courses	0	8	14	20	42	² (6)=23.41, p<. 05.	
	1	11	16	12	39		
	2	8	8	1	17		
	3	12	28	4	44		
Total		39	66	37	142		
# of Computer Courses	0	9	7	2	18	² (6)=7.93, p>.05.	
	1	12	27	12	51		
	2	9	13	12	34		
	3	9	19	11	39		
Total		39	66	37	142		

In addition, we found that students with or without AP social studies courses chose STEM majors in similar numbers (see Table 5.) even though there was significant a relationship between students' AP social studies enrollment and their major choice (see Table 5.). Another interesting finding of this relationship was that students of non-STEM majors with 1 or more AP social studies course (28) were less than those of STEM majors with 1 or more AP social studies course (35). In other words, students of STEM major choices took more AP social studies courses than students of non-STEM major selection.

Total number of AP courses taken was significant as expected (see Table 5.). As students took more AP courses regardless of course types, they were more likely to choose STEM majors. The importance of AP course taking was apparent when the total number of STEM major-choosing

students (66) is compared with the total of non-STEM major-choosing and undecided students (76) in terms STEM major choice.

The last and third question looks at the relationship between students' number of computer course taking and their STEM major preference. Although there was not a statistically significant relationship between them, it was clear that students with more computer course taking preferred more STEM majors than the students with no computer course taking (see Table 5.).

Summary

In this study, we investigated three research questions. In the first one, we looked at the relationship between students' SAT reading, mathematics, composite, and total scores and their STEM major choices. We found that students' SAT reading, composite, and total scores had statistically significant relationship with students STEM major choice. Even though there was not a statistically significant relationship between students' SAT math scores, there was a pattern showing that students with higher SAT math scores were more inclined to choose a STEM major. SAT scores continued to be an important indicator not only for students' college success but also for their major selection as found in previous research.^{1,25}

The second question examined the difference between students' # of AP science, # of AP mathematics, # of AP social studies, and # of AP course enrollments and their STEM Major choices. The study showed that there was a statistically significant relationship between the number of students' AP science and AP courses and their STEM major selections. We also found that students with more AP mathematics courses were more likely to pursue in STEM-related majors. These are all consistent with Robinson's 2002 and 2003 findings^{21,22} in which it was found that students who took AP calculus and science classes chose majors such as science, engineering, mathematics, and the medical field.

The last question studied whether there was significant difference between students' # of Computer courses taken and their STEM major choices. In contrast to the expectation, there was no statistically significant difference between those but we found that those who chose STEM majors took more computer courses than those who did not choose. This was showing the expected relationship between the technology aspect of STEM and computer course enrollment.

We plan to study how students' engineering, other STEM major, and non-STEM major selection differ by their demographics (women, African American, Hispanics, and economically disadvantaged) as a future research.

This study showed that in addition to pivotal role of SAT scores and AP course taking in students' college acceptance and major selection, we now learned that computer course taking has an affect on students' STEM major preference that cannot be ignores. So education, policy, philanthropic, and business leaders should pay special attention to the role of computer course taking in cultivating STEM interest in students to meet the need of STEM professionals that the United States have to have in this global age.

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