# *Student Enrollment in High School AP Sciences and Calculus: How Does It Correlate With STEM Careers?*

**Mike Robinson**
***University of Nevada, Reno***

*Many high schools offer students the opportunity to take advanced placement (AP) courses in many subjects including science and mathematics. Studies have shown that students who take these classes are more likely to succeed in college and that failure in engineering education is strongly correlated to deficiencies in mathematics and science. This article presents the background of AP classes and their impact on science, technology, engineering, and mathematics (STEM) career choices of college students. The results of this study confirm that students who take AP classes in calculus and the sciences are more likely to select majors in careers such as engineering, science, mathematics, and the medical field. In this study, both minority and nonminority students who were taking AP calculus and/or science courses in high school selected STEM careers at a higher rate than other careers and males selected engineering at a higher rate than females. Females selected science and mathematics and the medical field at a higher rate than males. Furthermore, the size and location of the high school, profession of parents, and socioeconomic level of parents all affect the number of AP classes offered in high schools as well as which ethnic groups primarily take them.*

***Keywords:*** *AP science, high school, secondary science*

A problem with many high schools is that challenging courses are not offered, especially in mathematics and the sciences. In its final report of 2001, the National Commission on the High School Senior Year urged states to offer challenging alternatives to the traditional high school senior year. The report said that not enough high schools are preparing students for college and careers and that although 70% of today's high school graduates go on to some form of postsecondary education, only one half of those who enroll at 4-year institutions leave with a degree. The main reason cited was that they were not prepared for the rigors of college academics in high school. It proposed that the college-preparatory track be the learning track for all, not just the privilege of a few (CNN, 2001).

This proposal is certainly not new. The Committee of Ten (Eliot, 1893) as far back as 1893 tried to promote uniform college entrance requirements by aligning high school subjects and content with what would be taught in college. After *Sputnik I* in 1957, *U.S. News & World Report* carried an article ("What Went Wrong With American Schools," 1957) that advocated that the United States emulate the Soviet Union schools in stressing mathematics and science. In 1982, Mortimer Adler wrote a book about the need for a standardized, rigorous K-12 curricula that would be the same for all students (Adler, 1982). Many reports came out in the 1980s stressing the need for more rigorous high school academic requirements to prepare our country to compete with our economic rivals. The most famous of these was *A Nation at Risk* (National Commission on Excellence, 1983, p. 5).

Experience has shown that educational reforms can improve education. In the past 20 years, there have been increases in achievement in mathematics and science attributed to the reforms that went on mainly between 1982 and 1994. Challenging academic courses increased from 14% to 52% between 1982 and 1994, and the number of students taking advanced placement (AP) courses nearly tripled. Also, in general, scores in mathematics and science on the National Association of Education Progress (NAEP),

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the so-called nation's report card, increased from 1978 to 1992. Still, in the 1996 NAEP, only 3% of Grade 12 students performed at the advanced level, 18% at the proficient level, 36% at basic, and 43% below basic. Males outperformed females in basic, proficient, and advanced. Average proficiencies of minority groups, Black students, and Hispanic students were also at least 4 years behind those of their White peers (U.S. Department of Education, 2001). Unfortunately, in the most recent NAEP, 2000, there was no significant change from the 1996 NAEP. In fact, there was a slight decline of three points (4%) in students' average scores in Grade 12 (U.S. Department of Education, 2001). Furthermore, in international comparisons, the Third International Mathematics and Science Survey (TIMSS International Study Center, 1996), U.S. 12th graders' performance was among the lowest of the participating countries in mathematics, science general knowledge, physics, and advanced mathematics.

Many U.S. schools offer students the opportunity to take college-level classes in mathematics and science (U.S. Department of Education, 2000). Studies have shown that students who take these classes are more likely to have higher SAT scores and to succeed in college (Bracey, 1995). Other studies have shown that failure in engineering education is strongly correlated to deficiencies in mathematics and science (Budny, Bjedov, & LeBold, 1997). This article gives a brief background of the AP programs in U.S. high schools and surveys one medium-sized western school district for AP class offerings.

## AP Programs

As early as the 1950s, there was concern among educators in higher education as well as in high schools that our most talented students were not being challenged in existing high school courses. Course content and rigor, graduation requirements, and inconsistent college admission requirements were all cited as weaknesses for successful college work. A study titled "General Education in School College," sponsored by the Ford Foundation in 1952, recommended the development of achievement exams to enable high school students who passed them to get university credit in single subjects. In 1954, the Educational Testing Service (ETS) developed the exams, called AP, and during the school year (SY) 1955-1956 the AP program became a program of the College Board (Potter & Lena, 2000).

Given the variety of courses in high school (e.g., honors, college preparation, gifted, etc.), it is difficult for parents, educators, employers, and college admissions officers to determine the quality of the courses, for example, what standard the content meets and what a particular grade in a course means. This is especially true given the grade inflation of many high schools where the average grade point average (GPA) may exceed 3.0 for graduating high school seniors, with some students even having GPAs above 4.0. As more and more students try to attend college, GPAs are rising, but at the same time, SAT scores are remaining static or falling. An A average was a worthy achievement of entering college freshmen at the University of California, Los Angeles (UCLA) in 1969, with only 12.5% of students achieving it. But in 1999, 34% of entering college freshmen at UCLA indicated an A GPA (Wildagsky, 2000). Some universities are even dropping the SAT and the American College Test as part of the entrance requirements. In the past, these nationally standardized achievement tests served as a benchmark for the many students who applied. Now, standardized test scores may be of even more value with grade inflation and the difficulty in assessing the content of many "college preparatory" courses. AP courses can offer some of the same predictability for college success that the SAT and the American College Test have. The big advantages of AP courses are they are consistent in their standard for content, the same exam is administered externally to all students, and the standard is known and can be accepted by parents, teachers, and college admissions officers. Moreover, even if the high school AP grade is inflated, the AP examination score can still be used by college admissions officers to judge academic potential. The range on AP exams is from 1 to 5, with most colleges and universities accepting 3 as the minimum score needed for college credit. The College Board stated, "AP provides a true national standard of achievement that is consistent over time"; furthermore, according to the ETS and the College Board, the average SAT scores of AP graduates are often 164 points higher than the combined national average scores (College Board, 2000).

Currently, more than 100,000 teachers worldwide teach AP courses. The program is strengthened by their participation in professional development workshops and summer institutes and in the annual AP Reading where thousands of AP teachers and college faculty gather at college sites across the United States

to score the AP exams using rigorous guidelines. The AP program currently offers many courses in many subject areas. Each course is developed by a committee composed of college faculty and AP teachers and covers the breadth of information, skills, and assignments found in the corresponding college course. High school teachers use the AP course descriptions to guide them. The course description for each discipline outlines the course content, describes the curricular goals of the subject, and provides sample examination questions. Although the course descriptions are a significant source of information about the course content on which the AP exams will be based, AP teachers have the flexibility to determine how this content is presented. Published in the spring of the SY before the course will be taught, the course descriptions are available in the *AP Central*, accompanied by a course overview written by an experienced AP teacher. The following facts are taken from the *College Board Annual Report* (College Board, 2001).

### AP Program Facts

- The AP program offers 35 courses in 19 subject areas.
- Nearly 60% of U.S. high schools participate in the AP program. In those schools, 820,880 students took AP exams in 2001.
- In 2001, 1,414,387 AP exams were administered worldwide.
- More than 60,000 teachers worldwide attended AP workshops and institutes for professional development in the past year.
- More than 90% of the nation's colleges and universities have an AP policy granting incoming students credit, placement, or both for qualifying AP exam grades.
- Some 50% of U.S. colleges and universities offer sophomore standing to students who have a sufficient number of qualifying grades.
- A 1998 ETS study concluded that students with qualifying grades of 3 or above on AP exams earn higher grades in advanced college courses than classmates who have taken the prerequisite college course.
- Recent data show that AP students tend to follow the same course of study at college that they began in AP. This is particularly true of AP students of biology, physics, calculus, studio art, and Spanish literature.

## Access and Equity in AP Programs

In 2001, the federal government provided more than 20 million dollars to more than 40 U.S. states and territories to subsidize AP exam fees for low-income students and to provide support for AP teacher professional development and instructional resources for AP classes. In 2002, the U.S. Department of Education gave 18 states and the District of Columbia $6.5 million to encourage low-income students to take AP courses. According to the U.S. Secretary of Education Rod Paige, "these grants can help close the achievement gap between students from disadvantaged backgrounds and their peers"; the money will pay for low-income students in urban areas to prepare for and take AP tests and pay for online courses in rural areas where courses may not be available (CNN, 2001).

## Method

### Research Question

An earlier article (Robinson, Fadali, Ochs, & Willis, 2002) indicated that students who take high school AP physics are more likely to pursue engineering and other science, technology, engineering, and mathematics (STEM)–related programs at the university level than students who do not take AP physics in high school. This article is a follow-up of that study, and it includes a broader range of students who take AP classes in high school. The current article surveyed the AP course data in a medium-sized western school district to determine the number of AP classes offered in calculus and the sciences of biology, chemistry, and physics, as well as the percentage of students, including minorities, opting to take these classes. The data are used to assess the impact of these classes on the number of students who plan university study that leads to STEM careers. The following research questions addressed in this article have relevance to attracting and retaining students in STEM programs at the college level: (a) Are nonminority students who take AP courses in calculus and/or biology, chemistry, and physics in high school more likely to pursue college majors in STEM than students who do not take these AP courses? (b) Are nonminority male students who take AP calculus and science courses more likely to pursue college majors in STEM than nonminority female students? (c) Are minority students who take these previously mentioned AP classes more likely to pursue college majors in STEM?

### Participants

The data are from eight high schools in a diverse school district of approximately 58,000 students. The school district has nine large comprehensive high schools and one smaller high school with a total of more than 15,000 students in Grades 9 through 12. Two of the high schools did not respond to the survey or responded too late to be included in the data. In general, the district serves a lower-middle to upper-class social economic class, and the median income of a family of four is $58,400 per year. The single largest minority is Hispanics. This group has grown rapidly since the 1980s when it composed less than 5% of the total school population to the current nearly 20%. The percentage of Asian American and Pacific Islanders has also grown significantly during this time period, but the percentage of African Americans and Alaskan/Native Americans has stayed relatively constant.

The class enrollments (see Table 1) for the classes addressed in the study for the fall semester of SY 2002 were as follows: Grade 9, 5,365; Grade 10, 4,084; Grade 11, 2,799; and Grade 12, 3,264—or a total high school enrollment of 15,512. The breakdown by ethnic group (see Table 1) was as follows: Grade 9, 1,893 minorities of which 142 were Native American/Alaskan Native, 300 were Asian/Pacific Islander, 1,257 were Hispanic, and 194 were African American; Grade 10, 1,197 total minorities of which 84 were Native American/Alaskan Native, 271 were Asian/Pacific Islander, 704 were Hispanic, and 138 were African American; Grade 11, 648 total minorities of which 52 were Native American/Alaskan Native, 180 were Asian/Pacific Islander, 343 were Hispanic, and 73 were African American; Grade 12, 877 total minorities of which 65 were Native American/Alaskan Native, 213 were Asian/Pacific Islander, 495 were Hispanic, and 104 were African American. By gender, of the 4,615 total minorities in the school district, 52% were males and 48% were females.

Approximately 70% of the graduating seniors said they would be attending institutions of higher learning after graduation. The institutions range from universities to community colleges to trade schools. The state in which the data were collected also offers a millennium scholarship, $10,000 per student over 4 years of college, and of the 65% of graduating seniors who were eligible for it in SY 2000-2001, 75% took it. Their average GPA was 3.36.

The personal data for the AP students who responded to the survey were as follows: The ages ranged from 14 to 18. Six ethnic origins including "other" were recorded. More females than males were taking AP classes in total and in every group except Asian/Pacific Islander and other. The total ($N$ = 315) numbers of males and females were 154 and 161, respectively. In the minority groups ($n$ = 59), 36 males and 33 females were in AP classes. In the Caucasian non-Hispanic group ($n$ = 246), 118 were males and 128 were females. AP students were in Grades 9 through 12, but Grade 12 had most of the students. See Table 2 for the breakdown of personal data.

### AP Course Data

Although data were available for a number of years, only the most current data from SY 2002-2003 were used. All AP courses in the 10 high schools were surveyed with approximately a 50% return rate for AP courses from 8 of the 10 high schools. The 8 responding high schools offered AP courses in one or more of the following courses: American government, American history, art, biology, calculus, chemistry, English, environmental science, French, German, physics, Spanish, statistics, and trigonometry/precalculus.

The most common AP courses offered included English, American history, and American government, but in general, the best response rates came from the AP science courses, and the results of this study will come from those courses. The student responses by all AP courses are given alphabetically as follows: 38 for American government, 77 for American history, 2 for art, 63 for biology, 59 for calculus, 121 for chemistry, 72 for English, 33 for environmental science, 13 for French, 1 for German, 59 for physics, 25 for Spanish, 6 for statistics, and 3 for trigonometry/precalculus. A total of 572 AP course units were reported in the data of students who responded. This was an average of 1.81 courses per student (see Table 3).

## Results

Research Question 1 was, Are nonminority students who take AP courses in calculus and/or biology, chemistry, and physics in high school more likely to pursue college majors in STEM than students who do not take these AP courses? The career choices were lumped into the seven most common areas. Other choices with small numbers that are not listed here were law (7), architecture (4), education (3), and theology (2). Engineering included all of the common areas of study including electrical, mechanical, civil, com-

**Table 1. Breakdown of Total Student Numbers by Ethnic Group**

| Grade | Total Enrollment | Total Minorities | Native American/ Alaskan Native | Asian/ Pacific Islander | Hispanic | African American | Caucasian/ Non-Hispanic |
|---|---|---|---|---|---|---|---|
| 9 | 5,365 | 1,893 | 142 | 300 | 1,257 | 194 | 3,472 |
| 10 | 4,084 | 1,197 | 84 | 271 | 704 | 138 | 2,887 |
| 11 | 2,799 | 648 | 52 | 180 | 343 | 73 | 2,151 |
| 12 | 3,264 | 877 | 65 | 213 | 495 | 104 | 2,387 |
| Total | 15,512 | 4,615 | 343 | 964 | 2,799 | 509 | 10,897 |
| Percentage | 100 | 29.8 | 2.3 | 6.2 | 18.0 | 3.3 | 70.2 |

**Table 2. Personal Data of the Advanced Placement Students**

| Personal Date | *n* |
|---|---|
| Age | |
| 14 | 2 |
| 15 | 14 |
| 16 | 140 |
| 17 | 139 |
| 18 | 20 |
| Total | 315 |
| Grade level | |
| 9 | 1 |
| 10 | 1 |
| 11 | 142 |
| 12 | 171 |
| Total | 315 |

| | Ethnic Origin | | | | | | |
|---|---|---|---|---|---|---|---|
| | Native American/ Alaskan Native | Hispanic | Asian/ Pacific Islander | African American | Other | Caucasian | Total |
| *n* | 5 | 14 | 32 | 4 | 14 | 246 | 315 |
| Male | 2 | 6 | 19 | 1 | 8 | 118 | 154 |
| Female | 3 | 8 | 13 | 3 | 6 | 128 | 161 |

puter, and geological. There was one nuclear engineering choice. Science and mathematics included all of the common sciences such as biology, chemistry, and physics as well as biochemistry and astronomy. Humanities included college studies in English, history, political science, psychology, anthropology, philosophy, foreign language, and criminal justice. The medical field included premed and predental as well as nursing, pharmacy, and veterinary medicine.

The following results for Question 1 were obtained. The totals for engineering (71, 20.0%) and science and mathematics (77, 21.7%) were higher than for any of the other areas. The closest area behind engineering and science and mathematics was undecided with 69 (19.4%) followed by the medical field with 53 (14.9%), humanities with 47 (13.2%), business with 29 (8.1%), and fine arts with 8 (2.2%) (see Table 4). It must also be pointed out that the numbers are much

**Table 3. Advanced Placement Enrollment by Course in the Fall of School Year 2002-2003**

| Course | *n* |
|---|---|
| American history | 77 |
| American government | 38 |
| Art | 2 |
| Biology | 63 |
| Calculus | 59 |
| Chemistry | 121 |
| English | 72 |
| Environmental science | 33 |
| French | 13 |
| German | 1 |
| Physics | 59 |
| Spanish | 25 |
| Statistics | 6 |
| Trigonometry/precalculus | 3 |
| Total | 572 |

higher for the career choices than one would expect because many students listed more than one career choice, and many students were taking more than one AP course so the career choice(s) was listed for each course they were enrolled in.

The following results were obtained in answer to Research Question 2, Are nonminority male students who take AP calculus and science courses more likely to pursue college majors in STEM than nonminority female students? Nonminority male students ($n = 118$) chose engineering ($n = 51$, 28.0%) more often than nonminority females ($n = 128$) chose engineering ($n = 20$, 11.6%). The males chose business ($n = 18$, 9.8%) more often than females ($n = 11$, 6.3%). But females chose science and mathematics ($n = 42$, 24.4%) more often than males ($n = 35$, 19.2%), humanities ($n = 29$, 16.8%) more often than males ($n = 18$, 9.8%), and the medical field ($n = 35$, 20.3%) considerably more often than males ($n = 18$, 9.8%). The choices of undecided and fine arts were quite close (see Tables 5 and 6).

The following results were obtained in answer to Research Question 3, Are minority students who take these previously mentioned AP classes more likely to pursue college majors in STEM? The single largest choice for minority students ($n = 69$) was engineering ($n = 27$, 20.7%) followed by the medical field ($n = 24$, 18.4%) and undecided ($n = 22$, 16.6%). Science and mathematics had 21 (16.1%), business had 18 (13.8%), humanities had 14 (10.7%), and fine arts had 2 (1.5%). See Table 7.

Minority enrollment was also broken down by gender (see Tables 8 and 9). Many more males ($n = 22$, 32.3%) chose engineering than did females ($n = 5$, 8.3%). Males ($n = 13$, 19.1%) also exceeded female ($n = 8$, 13.3%) numbers in science and mathematics. More females ($n = 13$, 21.6%) chose the medical field than did males ($n = 11$, 16.1%). Many more females ($n = 14$, 23.3%) chose business than did males ($n = 4$, 5.8%). Humanities, fine arts, and undecided were close for both groups.

Career choices were also compared by ethnicity among the minorities (see Table 10). Asian Pacific and other had the most choices for engineering, 15 and 7, respectively, followed by Hispanics at 5. Asian Pacific and other also had the highest numbers of science and mathematics, but African American was also high, given the small number. Asian Pacific was by far the highest in the medical field with 13 compared to other with 4. Asian Pacific was also the highest for business, but most of the numbers were female.

## Discussion and Conclusions

Much has been written concerning the need to offer a more challenging curriculum to high school students if they are to be motivated to finish high school and to be prepared for university and career choices that may as a prerequisite require rigorous high school work. It is also apparent that to make reliable decisions about what curriculum is needed in high school to prepare students for higher education and career choices, school districts should be collecting more data. Judging from this study, one would surmise that 40% to 50% of Hispanics are not finishing high school (see Table 1), and a far lower percentage are taking AP classes than nonminority Caucasian students, Asian Pacific students, and other. Table 1 also shows that there are more students in Grade 12 than Grade 11 in every category. A school district authority said this is because of the following: At the end of Grade 10, many students do not have enough credits to be classified as Grade 11, but they take summer school and repeat failed classes during what would have been Grade 11 classification. This gives them enough credits in their 12th year to become seniors (Grade 12) without ever being classified as juniors or Grade 11 students.

We have no real evidence, but Asian students appear to be predominantly of Chinese, Vietnamese, and Korean origins in the surveyed district. Other seems to be represented by South Asians, Pakistan and Indian origins, and Middle Easterners. In this study, the numbers of African American and Native American students are so small that little can be said about their rep-

**Table 4. Total Advanced Placement (AP) Enrollment and College Career Choices for All Nonminority Students**

| | College Career Choice | | | | | | |
|---|---|---|---|---|---|---|---|
| **AP Course** | **Engineering** | **Science or Mathematics** | **Medical Field** | **Humanities** | **Business** | **Fine Arts** | **Undecided** |
| Biology | 6 | 19 | 8 | 5 | 5 | 1 | 8 |
| Calculus | 21 | 19 | 13 | 13 | 8 | 1 | 16 |
| Chemistry | 22 | 20 | 23 | 16 | 9 | 6 | 31 |
| Physics | 23 | 19 | 9 | 13 | 7 | 0 | 14 |
| Total | 71 (20.0) | 77 (21.7) | 53 (14.9) | 47 (13.2) | 29 (8.1) | 8 (2.2) | 69 (19.4) |

Note: Numbers in parentheses indicate percentages.

**Table 5. Advanced Placement (AP) Enrollment and College Career Choices for Nonminority Male Students**

| | College Career Choice | | | | | | |
|---|---|---|---|---|---|---|---|
| **AP Course** | **Engineering** | **Science or Mathematics** | **Medical Field** | **Humanities** | **Business** | **Fine Arts** | **Undecided** |
| Biology | 2 | 7 | 3 | 1 | 3 | 1 | 3 |
| Calculus | 19 | 8 | 5 | 4 | 6 | 0 | 8 |
| Chemistry | 13 | 12 | 5 | 7 | 4 | 4 | 18 |
| Physics | 17 | 8 | 5 | 6 | 5 | 0 | 8 |
| Total | 51 (28.0) | 35 (19.2) | 18 (9.8) | 18 (9.8) | 18 (9.8) | 5 (2.7) | 37 (20.3) |

Note: Numbers in parentheses indicate percentages.

**Table 6. Advanced Placement (AP) Enrollment and College Career Choices for Nonminority Female Students**

| | College Career Choice | | | | | | |
|---|---|---|---|---|---|---|---|
| **AP Course** | **Engineering** | **Science or Mathematics** | **Medical Field** | **Humanities** | **Business** | **Fine Arts** | **Undecided** |
| Biology | 4 | 12 | 5 | 4 | 2 | 0 | 5 |
| Calculus | 6 | 11 | 8 | 9 | 2 | 1 | 8 |
| Chemistry | 4 | 8 | 18 | 9 | 5 | 2 | 13 |
| Physics | 6 | 11 | 4 | 7 | 2 | 0 | 6 |
| Total | 20 (11.6) | 42 (24.4) | 35 (20.3) | 29 (16.8) | 11 (6.3) | 3 (1.7) | 32 (18.6) |

Note: Numbers in parentheses indicate percentages.

**Table 7. Total Advanced Placement (AP) Enrollment and College Career Choices for AP Minority Students**

| | College Career Choice | | | | | | |
|---|---|---|---|---|---|---|---|
| **AP Course** | **Engineering** | **Science or Mathematics** | **Medical Field** | **Humanities** | **Business** | **Fine Arts** | **Undecided** |
| Biology | 5 | 3 | 4 | 4 | 7 | 0 | 4 |
| Calculus | 10 | 5 | 7 | 2 | 5 | 0 | 6 |
| Chemistry | 5 | 9 | 9 | 6 | 3 | 1 | 8 |
| Physics | 7 | 4 | 4 | 2 | 3 | 1 | 4 |
| Total | 27 (20.7) | 21 (16.1) | 24 (18.4) | 14 (10.7) | 18 (13.8) | 2 (1.5) | 22 (16.6) |

Note: Numbers in parentheses indicate percentages.

**Table 8. Advanced Placement (AP) Enrollment and College Career Choices for Minority Male Students**

| | College Career Choice | | | | | | |
|---|---|---|---|---|---|---|---|
| **AP Course** | **Engineering** | **Science or Mathematics** | **Medical Field** | **Humanities** | **Business** | **Fine Arts** | **Undecided** |
| Biology | 4 | 2 | 3 | 3 | 3 | 0 | 1 |
| Calculus | 8 | 3 | 3 | 2 | 1 | 0 | 3 |
| Chemistry | 4 | 5 | 3 | 1 | 0 | 0 | 3 |
| Physics | 6 | 3 | 2 | 2 | 0 | 0 | 3 |
| Total | 22 (32.3) | 13 (19.1) | 11 (16.1) | 8 (11.7) | 4 (5.8) | 0 (0) | 10 (14.7) |

Note: Numbers in parentheses indicate percentages.

**Table 9. Advanced Placement (AP) Enrollment and College Career Choices for Minority Female Students**

| | College Career Choice | | | | | | |
|---|---|---|---|---|---|---|---|
| **AP Course** | **Engineering** | **Science or Mathematics** | **Medical Field** | **Humanities** | **Business** | **Fine Arts** | **Undecided** |
| Biology | 1 | 1 | 1 | 1 | 4 | 0 | 3 |
| Calculus | 2 | 2 | 4 | 0 | 4 | 0 | 3 |
| Chemistry | 1 | 4 | 6 | 5 | 3 | 1 | 5 |
| Physics | 1 | 1 | 2 | 0 | 3 | 1 | 1 |
| Total | 5 (8.3) | 8 (13.3) | 13 (21.6) | 6 (10.0) | 14 (23.3) | 2 (3.3) | 12 (20.0) |

Note: Numbers in parentheses indicate percentages.

**Table 10. College Career Choices by Ethnicity**

| | College Career Choice | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Engineering** | | **Science or Mathematics** | | **Medical Field** | | **Humanities** | | **Business** | | **Fine Arts** | | **Undecided** | |
| **Ethnicity** | **Male** | **Female** | **Male** | **Female** | **Male** | **Female** | **Male** | **Female** | **Male** | **Female** | **Male** | **Female** | **Male** | **Female** |
| Asian Pacific ($n$ = 32) | 10 | 5 | 5 | 3 | 7 | 6 | 6 | 3 | 3 | 11 | 0 | 1 | 4 | 4 |
| Hispanic ($n$ = 14) | 5 | 0 | 1 | 0 | 0 | 2 | 0 | 1 | 1 | 2 | 0 | 0 | 2 | 3 |
| Other ($n$ = 14) | 7 | 0 | 2 | 3 | 4 | 0 | 2 | 1 | 1 | 0 | 0 | 0 | 1 | 2 |
| African American ($n$ = 4) | 0 | 0 | 4 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| Native American ($n$ = 5) | 0 | 0 | 1 | 2 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 1 | 3 | 0 |
| Total | 27 | | 21 | | 24 | | 14 | | 18 | | 2 | | 22 | |

resentative numbers in AP courses. The high school with the highest percentage of African Americans, for whatever reason, did not respond to the survey for the AP course data.

Administrators in colleges of engineering have long suspected that students who take AP calculus and upper division science courses (e.g., AP chemistry and physics) are more likely to pursue study in engineering in college. Based on the results from the three research questions, the following conclusions can be drawn regarding the correlation of student enrollment in AP science and mathematics courses to majoring in engineering and other STEM careers. At least regarding AP calculus, biology, chemistry, and physics, it is clear from these data that a majority of students who take these courses, males and females, expect to pursue STEM-related career tracks in college, although many were undecided and many were planning business or humanities study. Furthermore, based on the data from this study, it is recommended that high schools, counselors and teachers, encourage more minority students to take the challenging courses, for example, AP, that

will prepare them for college and/or better jobs after high school. To do this, they will need more encouragement and productive role models in the earlier grades so they understand the need to make an effort in school and take the challenging courses needed for better jobs and higher education preparation. AP classes, with their higher standard of course work, can reduce college costs and motivate students to achieve at a higher level as a result of the challenge inherent in AP courses and the types of students who elect to take these courses.

Additional data from the eight high schools, not included in this study, showed two trends that have some significance to increasing enrollment in college-level study leading to STEM careers. First, it appears that enrollments in AP courses are related to the socioeconomic levels of students. The higher socioeconomic level schools offer more AP courses and have more students enrolled in them. The common wisdom for this is that the higher socioeconomic level schools have "better" students and they are more able to take challenging AP courses. The author's experience in education indicates that the parents of these students are more likely to understand the lifelong advantages a good education provides and advocate for a more challenging curriculum, as well as having the political power to see that they get it. If minority students are to capitalize on the benefits of AP courses in high school, their parents must take a more active part in their education in elementary and middle schools. The federal aid mentioned earlier in the article (CNN, 2001) that aims to provide equity by providing access to AP courses for lower income and disadvantaged students is encouraging. It is hoped that more teachers, counselors, and other school officials will work with these students' parents to encourage more students to get the prerequisite courses in the lower grades to handle AP courses in high school. A grant proposal is currently being submitted that will deal with this need.

A second trend indicated by the data is the lack of AP courses in small and rural schools. This is being addressed by overseas American schools (e.g., Department of Defense and American Embassy schools) and some U.S. states through the implementation of distance learning and online programs for AP courses. Making AP courses available to both of these pools of students will certainly increase the prospect for more students to gain the needed mathematics and science skills for success in STEM career tracks in college.

Further research will address the impact of AP mathematics and science courses on attrition rates of students majoring in engineering. Do students in college engineering programs who took AP courses in high school have a lower attrition rate in engineering than students who did not have AP courses in high school? Intuitively, one would expect so. The data are currently being analyzed to answer this question and will be presented in a later article.

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*Mike Robinson is a professor of secondary science education at the University of Nevada, Reno. He teaches courses in secondary science teaching methods and supervises secondary science preservice teachers in the field. His research interests include environmental science literacy, engineering literacy, and teaching science with an STS approach.*