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Female Students in High School Physics

Results from the 2008-09 Nationwide Survey of High School Physics Teachers

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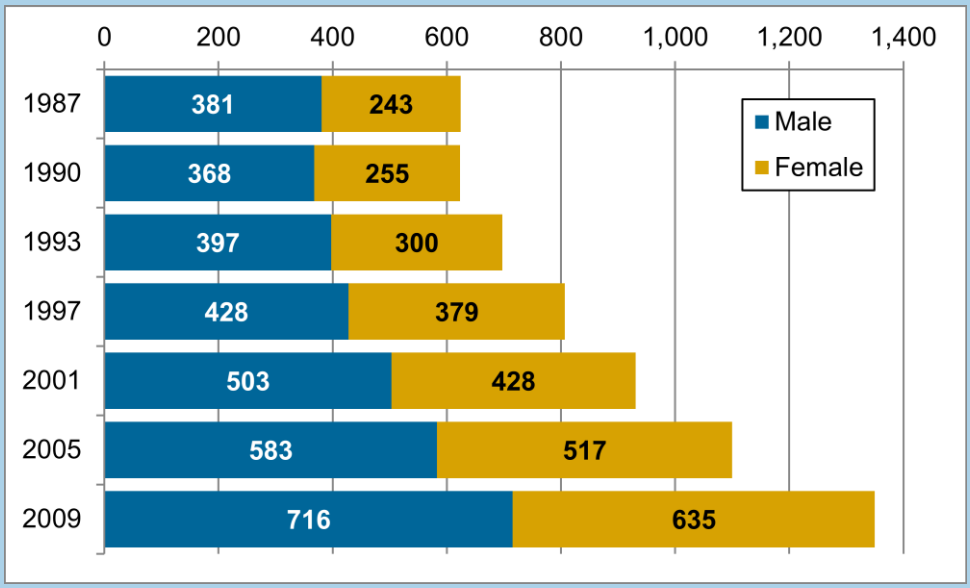
Number of Girls in HS Physics Continues to Grow

Between 1987 and 2009, the number of girls taking physics in US high schools increased 161%, while the number of boys was up 88%. (See Figure 1.) Proportionally, about 40% of high school physics students were female in 1987. This went up to about 47% in 1997 and has been remarkably consistent since. (See Figure 2 on the following page.)

The number of girls taking physics in high school is up, but growth is slower in advanced physics classes. The under-representation of girls in more advanced high school physics classes can have implications that extend well beyond a student's high school career. In this report, we will examine female representation by type of physics class, with a closer look at female representation in AP Physics. We will consider the implications of the lower representation of females in advanced high school physics classes.

Figure 1

Number of Male and Female Physics Students
All US High Schools



Numbers in thousands

http://www.aip.org/statistics

Reports on High School Physics

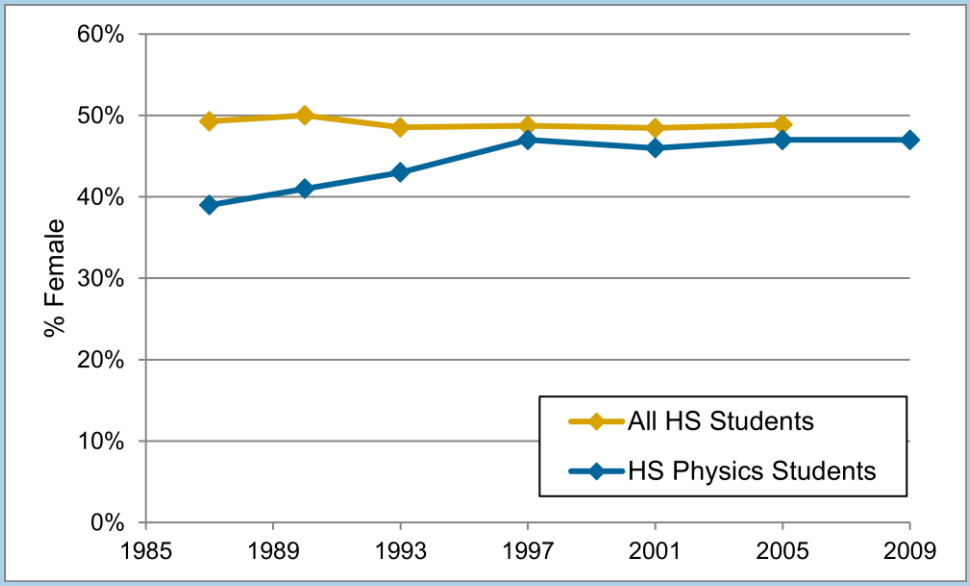
The 2008-09 Nationwide Survey of High School Physics Teachers

During the 2008-09 academic year, we contacted a representative national sample of about 3,600 public and private high schools across the U.S. to inquire about physics availability and offerings. These reports describe our findings.

As seen in Figure 1 (front page), the number of female physics students continues to grow. Female students represent about 47% of all physics students.

Figure 2

Proportion of Females among US High School Students
All US High Schools



Data for all high school students from US Department of Education, National Center for Education Statistics

http://www.aip.org/statistics

In an earlier report (*focus on Who Teaches High School Physics?*), we reported a slight growth to 32% for the proportion of high school physics teachers who are women.

Female Representation by Type of Course

In our 2009 survey, we asked teachers to tell us what proportion of the students in each of the physics classes they taught were girls. We last asked this question in 1993. Figure 3 provides data from both years.

While female representation has increased in every type of course, it is still true that female representation is lower in more advanced courses. This is true in both the 1993 and the 2009 data.

Even though the proportion of females among AP Physics C students was only 32% in 2009, the increase from 27% in 1993 means that the number of girls in AP Physics C is growing faster than the number of boys in AP Physics C.

As we noted previously, the under-representation of female students in the more advanced high school physics classes can have implications that extend well beyond a student's high school career. In our 2005 global survey of women in physics, we asked respondents when they

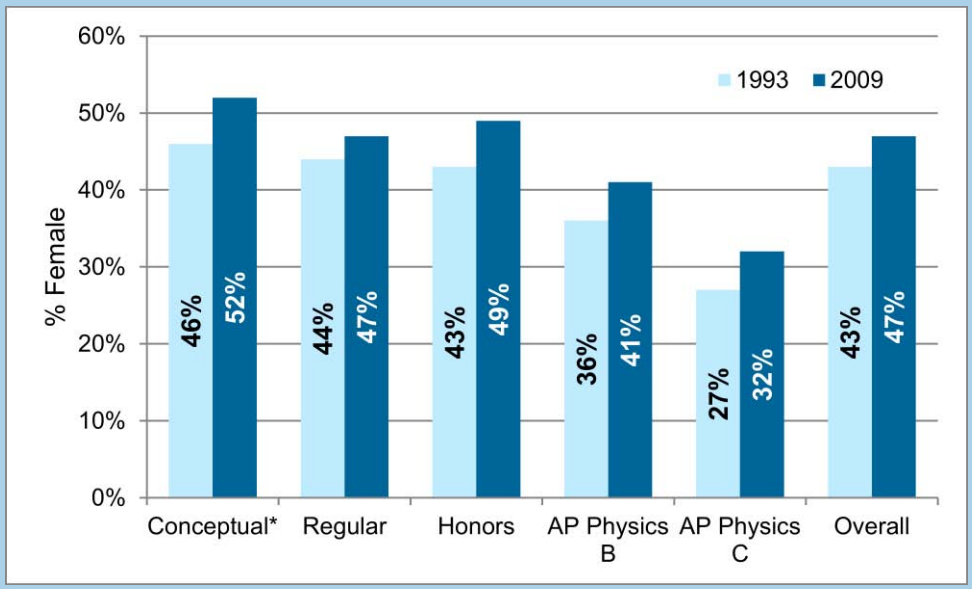
first thought of choosing physics as their career; 75% reported doing so either before or during high school.[1] We also know that the vast majority (93%) of students who receive physics bachelor's degrees took a physics course during high school.[2] The high school physics experience can affect a student's future academic path.

Perhaps the lower representation of female students is a by-product of the quantitative nature of the AP Physics B and AP Physics C courses. In order to examine this hypothesis, we looked at the data for students taking AP tests in 2009. In the AP data, we can examine two measures of female representation: females among students taking the exam and females among students passing the exam. If the quantitative nature of the course discourages female participation, courses with comparable levels of mathematical rigor should have comparable representations of females.

Overall, almost 2.9 million tests were taken in all subjects, and over half of these (55%) were taken by female students. About 1.7 million "passing" scores were posted, 52% by female students. Looking

Figure 3

Representation of Female Students among Physics Students by Type of Course
All US High Schools



*** Includes data for both Physics First and Conceptual Physics for 2009; Physics First data was not collected separately in 1993**

http://www.aip.org/statistics

The number of girls who are taking physics courses at all levels is growing faster than the number of boys taking physics.

[1] ***Women Physicists Speak Again*** by Rachel Ivie and Stacy Guo, 2006; for preliminary updated data, see **Global Survey of Physicists** by Rachel Ivie and Casey Langer Tesfaye, 4th IUPAP Conference on Women in Physics, 2011

[2] ***focus on Physics Bachelor's Demographic Profiles*** by Patrick Mulvey and Brandon Shindel, 2010

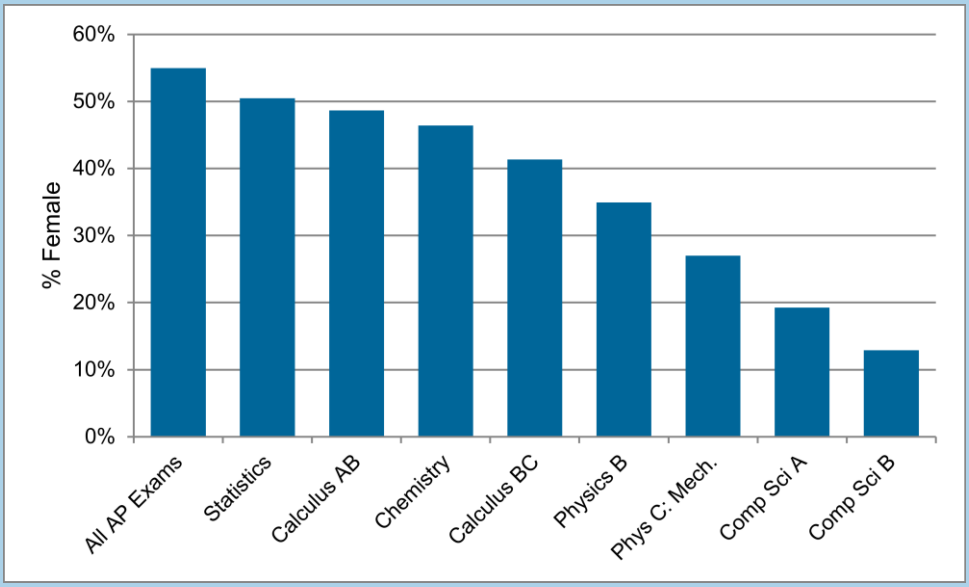
specifically at more mathematically rigorous subjects, we found that almost half of the students taking the AP Calculus AB exam were female, and over half of the students taking the AP Statistics exam were female. Furthermore, a larger percentage of female students passed the AP Calculus BC exam than passed the physics exams. (See Figure 6 on page 6.) These data do not appear to support the hypothesis that mathematical rigor can explain the low representation of females in AP Physics.

Data for females among test takers for several subjects are shown in Figure 4. For all AP exams given in 2009, only Computer Science A and B had a lower representation of females than Physics B and C. While these data are for 2009, other years do not differ significantly.

Mathematical rigor does not explain the low representation of females in AP Physics.

Figure 4

Female Representation in AP Exams, 2009
% of Females Taking Exams in Selected Subjects



Data from the College Board,
http://www.collegeboard.com/student/testing/ap/exgrd_sum/2009.html

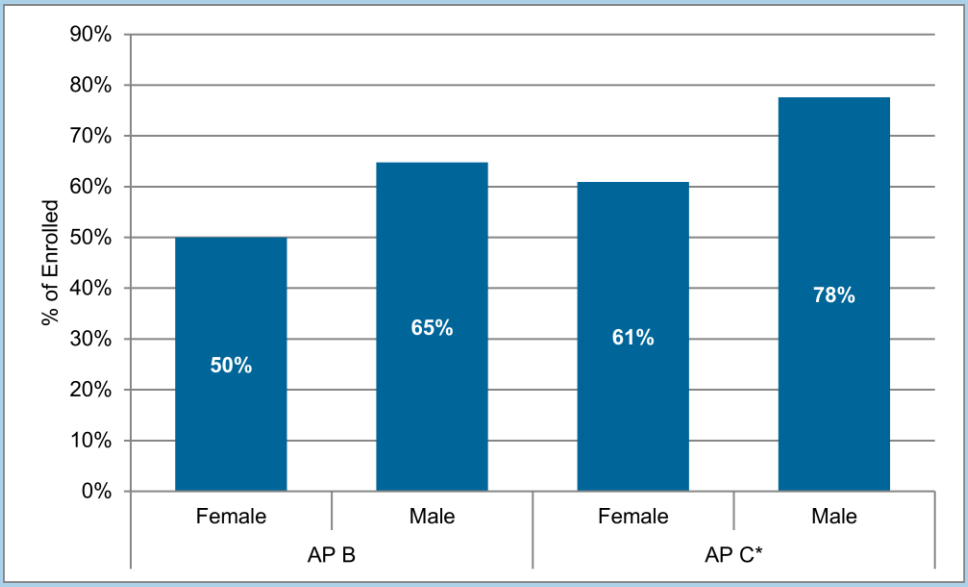
http://www.aip.org/statistics

The AP Physics Experience

Our data show that over 100,000 students were enrolled in AP Physics B during the 2008-09 academic year. Almost 40,000 were enrolled in AP Physics C during that same year. Yet, the number of students taking the AP exams is far below these enrollment numbers. College Board data indicate that about 60,000 students took the AP Physics B exam, and about 28,000 took the AP Physic C: Mechanics exam. Thus, about 60% of the students enrolled in AP Physics B took the exam, and about 70% of the students enrolled in AP Physics C took the Mechanics

Figure 5

Proportion of Students Who Elected to Sit for AP Physics Exams, 2009



*** The AP C exam data are for the AP Physics C: Mechanics exam only.**

The denominator is the number of students enrolled and comes from our survey data. The numerator—the number of students taking the exam—comes from the College Board.

AP Data from the College Board,
http://www.collegeboard.com/student/testing/ap/exgrd_sum/2009.html

http://www.aip.org/statistics

More students are enrolled in AP Physics than actually take the exam.

exam.‡ Do male and female students choose to take the exam at the same rate? Do they pass the exam at the same rate? No.

There is a marked difference in the proportion of female and male students enrolled in the course who take the exam. Figure 5 depicts these rates for both male and female students in AP Physics B and AP Physics C: Mechanics for 2009. Not only does a lower proportion of female students choose to take the exam, but the passing rate is also lower for females for both exams.

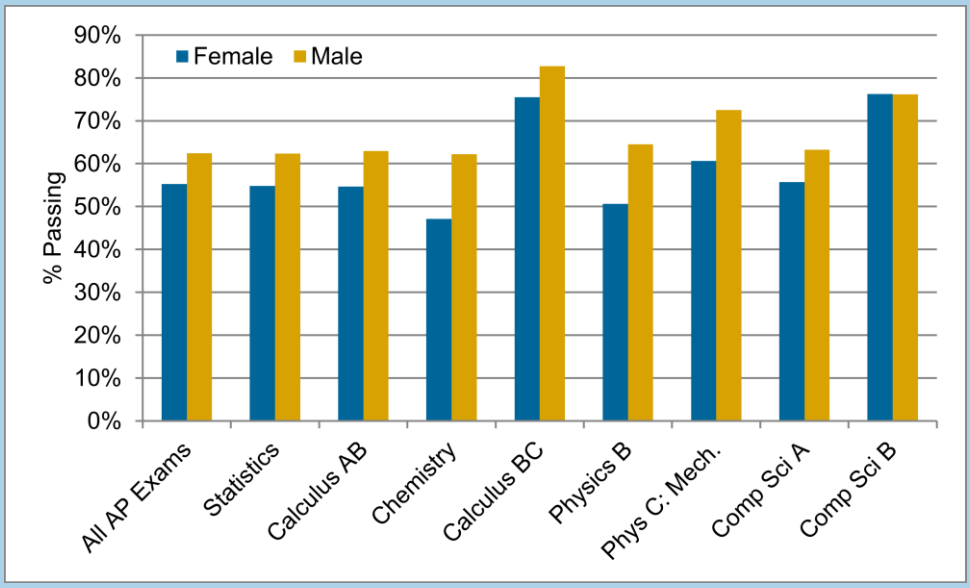
This phenomenon, with respect to the passing rate, is not limited to AP Physics exams. Figure 6 (on the following page) presents data on passing rates for various subjects. (We do not have enrollments for the other AP courses, so we cannot examine the proportion of students who choose to take the exam.) Interestingly, physics and chemistry show the largest differentials in the passing rates for males and females, with proportionally more male students scoring 3 or higher than female students. There is virtually no difference in the passing rate for the Computer Science B exam.

‡ We do not include the data for the AP Physics C: E&M since less than half the number of students who took the Mechanics exam took the E&M exam. They likely represent a subset of the students who took the Physics C: Mechanics exam.

For most of the AP exams (including Biology and other subjects not listed), a higher proportion of male students who take the test pass.

Figure 6

Proportion of Students Who Passed AP Exams, 2009
Selected Subjects



Scores of 3, 4, and 5 are considered passing scores.

The denominator here is the number of students taking the exam.

AP Data from the College Board,
http://www.collegeboard.com/student/testing/ap/exgrd_sum/2009.html

http://www.aip.org/statistics

There are a few subjects for which the female test takers post a higher passing rate than males. These are typically art (except art history) and selected languages.

Women in Physics

We have seen little change in female representation in high school physics courses, including AP Physics, since 1997. In addition, the proportion of females who earn bachelor's degrees in physics has been stagnant at just above 20% since the turn of the century. Women earn at least 40% of the bachelor's degrees in biology, chemistry, and math.

The reasons for lower female participation in advanced high school physics remain unclear. In many US high schools, physics is often taken in the final years of study. As we have documented, proportionally fewer female students choose AP Physics than choose less advanced physics classes. To examine why, we would need to look at factors which impacted these students *before* their final years of high school.

Did something in the earlier science curriculum discourage girls from more advanced physics? Or was it the general belief, widely embraced in our culture, that girls just don't "do" hard sciences?

Furthermore, why is it that female students in AP physics are less likely to even take the AP exams than male students are? Does something in the curriculum or teaching methods discourage them? Or is it something in the general culture? Are girls using AP physics as a means to prepare for college physics rather than earning AP credit? If so, why? And then, why are female physics students less likely to pass even when they take the AP exams? Are they victims of stereotype threat, which is a phenomenon that causes people to score lower when they expect to do so?

The reasons for lower female participation in advanced high school physics remain unclear.

These and other questions can only be answered with research that actually asks students these questions. Because these questions remain unanswered, we can offer no simple solution for increasing women's participation in physics. We will, however, continue to offer statistics as a way to measure women's progress in physics.

Survey Methodology

In the fall of 2008, we contacted a representative sample of over 3,600 high schools in the U.S., both public and private, to determine whether or not physics was taught there. We received responses from over 99% of the schools. For the schools which indicated they were offering physics, we obtained contact information for the teachers. In the spring of 2009, we contacted each of the teachers who were thought to be teaching physics. We received responses from over 2,500 teachers (a 62% response rate). Our findings are based on their responses.

For a copy of the principal survey or the teacher survey, please contact Susan White at swhite@aip.org.

We are able to conduct this research only with the gracious help of the more than 6,000 people who provided responses, including an administrator at each school and each of the teachers who responded. We are deeply grateful for their assistance and their time.

This marks the seventh time we have conducted a survey examining physics in U.S. high schools.