Moving Towards Equity in AP Computer Science

Emily Shepherd

1. **Introduction:** In Fall 2016, The College Board introduced AP Computer Science Principles. This course was promoted as a computer science course that did not need to be taught by a computer science teacher. Additionally, AP CSP was introduced to increase the number of students studying computer science, and also, increase the number of traditionally underrepresented students studying computer science. By analyzing the test data released by The College Board for the AP CSA test from 2010 to 2019 and the AP CSP test from 2017 to 2019, the following questions will be examined:
    - Did the number of AP CSA tests significantly increase from 2010 to 2019?
    - Did the number of AP CSP tests significantly increase from 2016 to 2019?
    - Was there a significant jump in AP CSA participation after the introduction of AP CSP?
    - Did the participation of traditionally underrepresented populations, such as girls and non-white students, increase with the introduction of AP CSP?
    - Is there a significant difference in pass rates between white male students and traditionally underrepresented students?
2. **Initial Exploration of Data:** The data available consisted of state level data for AP CSA and AP CSP. Variables included in the datasets included number of tests administered, including desegregated data based on sex and race. The data also included both the number of passing tests and the percent passing, also desegregated by sex and race. The AP CSA data included the data for years 2010 through 2019, and the AP CSP data included data for years 2017 to 2019.

    Initially, by looking at the data over time, a pattern can be observed that there is an increase in both number of students taking AP computer science tests and the number of students passing AP computer science tests.

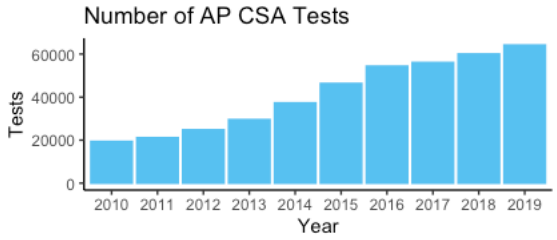

Fig. 1: Plot of Number of CSA tests, 2010-19

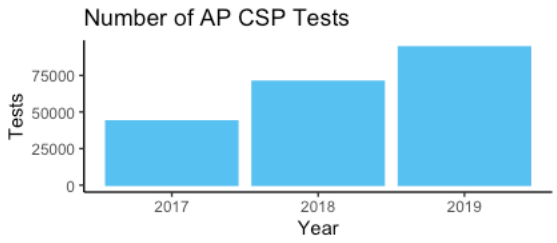

Fig. 2: Plot of Number of CSP tests, 2017-19

From the plots above, we can observe an increase in the number of tests administered for both AP CSA tests and AP CSP tests. However, the increases from in number of AP CSA tests appear to be minimal from 2017 to 2018 and 2018 to 2019, which is after the introduction of the AP CSP tests.

Looking at the number passing, we see there is also a general increase.

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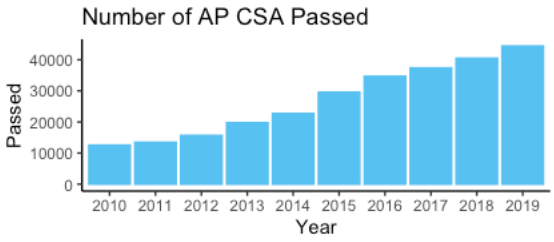

Fig. 3: Plot of Number of Passing CSA tests, 2010-19

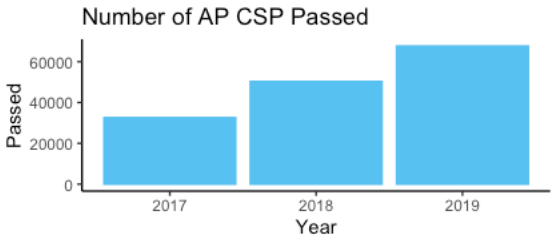

Fig. 4: Plot of Number of Passing CSP tests, 2017-19

The plots for passing tests and total tests look similar for each course. Looking at a plot for the percent passing for each test, we observe that the pass rates stay constant over the years.

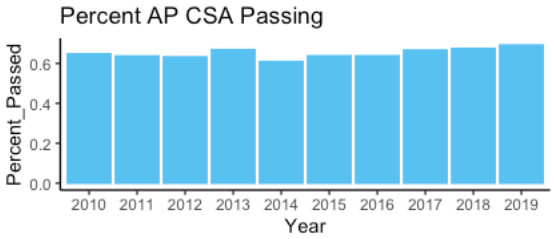

Fig. 5: Plot of AP CSA Passing Rate, 2010-19

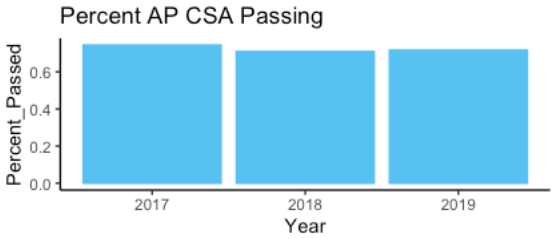

Fig. 6: Plot of AP CSP Passing Rate, 2017-19

The consistency of the pass rates is not that interesting because the advanced placement tests are norm-referenced. The cut scores are determined after the tests are graded to keep the pass rates relatively constant.

Next, one-way ANOVA analysis was conducted on both the AP CSP total tests and AP CSA total tests, using a factor of years. For the AP CSP test, the p-value equal to 0.09582, indicating there is not a significant association between the number of tests and the year. For the AP CSA test, there was a significant association between year and number of tests, with a p-value equal to 0.00413. However, after completing TukeyHSD, there was no significant interactions among the years 2017-2019, when the AP CSP test was implemented.

3. Analysis of Participation by Sex: Girls are underrepresented in computer science courses and the field of computer science overall. One of the objectives for the introduction of AP Computer Science Principles is to increase the number of girls in computer science courses and eventually in the field of computer science.

For AP CSA, there is a huge difference in the number of boys enrolled and the number of girls enrolled.

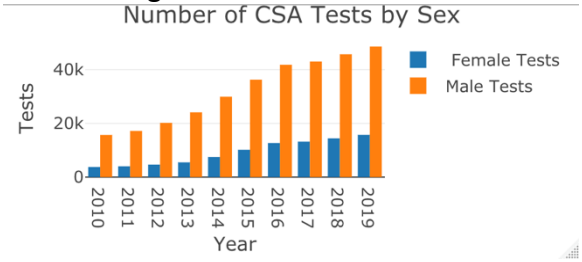

Fig. 7: Grouped Bar Graph of Number of Female and Males AP CSA Tests, 2010-19

For AP CSP, we see a difference still exists in number of females tested and number of males tested. However, the differences do not seem as large.

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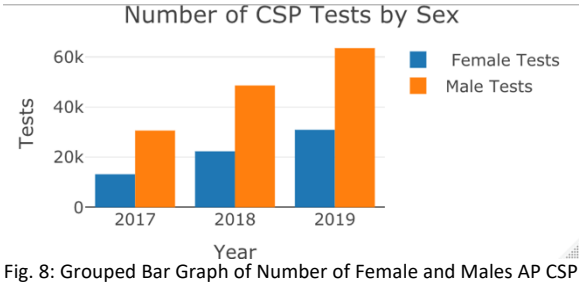

Fig. 8: Grouped Bar Graph of Number of Female and Males AP CSP Tests, 2017-19

It appears from Figure 8, that by 2019, the number of females who take the AP CSP is about half the number of males who take the test. To determine whether these increases are significant, a z-test for the difference in proportions was conducted to determine of the change was statistically significant. The assumption is that the proportion of girls taking the test in 2017 is independent of the proportion of girls taking the test in 2019.

$$H_0: p_{2019} \leq p_{2017}$$
$$H_A: p_{2019} > p_{2017}$$

This test resulted in a test statistic z = 9.851 and a p-value of less than 0.001. This leads to the conclusion that the proportion of girls taking the AP CSP test in 2019 had significantly increased from 2017, when the course was first introduced.

The next question is whether the proportion of females have also significantly increased in AP CSA, since the introduction of AP CSP. Once again, a z-test for the difference in two proportions was run.

$$H_0: p_{2019} \leq p_{2017}$$
$$H_A: p_{2019} > p_{2017}$$

Once again, the z-test concluded that there was a significant increase in the proportion of girls taking the AP CSA test. However, it should be noted, that the percent of girls is still under 25%.

4. Analysis of Participation by Race:

Another concern in computer science education is the lack of Black and Hispanic students enrolled in computer science classes and then eventually pursue careers in technology. I first explored this issue as I did before by plotting the number of CSA and CSP tests over the years for Black, Hispanic, and white students.

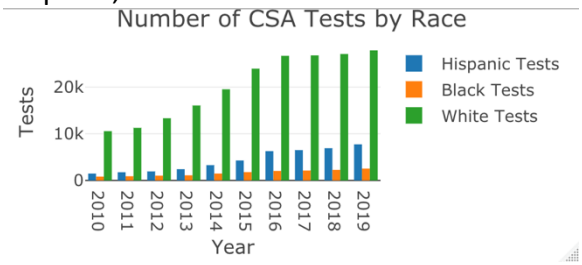

Fig. 9: Grouped Bar Graph of Number of Hispanic, Black, and White AP CSA Tests, 2010-19

From figure above, we can see there was a general increase for all three racial groups through 2017, but then it the number of tests leveled off. However, looking at the companion plot for AP CSP tests, we see that the number of tests for all three groups increased from 2017 to 2019.

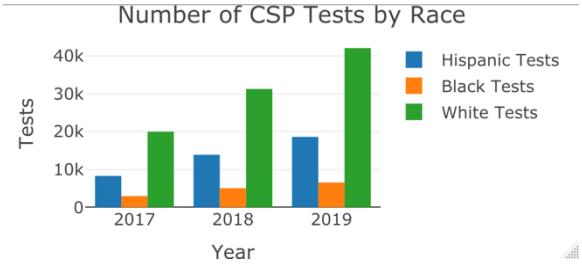

Fig. 10: Grouped Bar Graph of Number of Hispanic, Black, and White AP CSP Tests, 2017-19

From looking at the graphs, further analyses of the increases in participation needed to be explored, using a z-test for the difference in proportions. I ran the tests with the following hypotheses for all three racial groups and both tests.

$$H_0: p_{2019} \leq p_{2017}$$
$$H_A: p_{2019} > p_{2017}$$

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For the CSA test, the results are recorded in the table below:

Group	$\hat{p}_{2019}$	$\hat{p}_{2017}$	z-score	p-value
Black	0.039	0.037	1.662	0.0482
Hispanic	0.120	0.116	2.502	0.0062
White	0.434	0.478	-15.22	1

For the CSP test, the results are recorded in the table below:

Group	$\hat{p}_{2019}$	$\hat{p}_{2017}$	z-score	p-value
Black	0.069	0.062	5.451	<0.001
Hispanic	0.197	0.189	3.463	<0.001
White	0.446	0.456	-3.733	0.9999

From the above hypothesis tests, there was a significant increase in participation rate for Black and Hispanic students since the introduction of the AP CSP exam for both AP CSA and AP CSP. However, the participation rate does not match the percentage of school age students who are Black or Hispanic. According to the Center for Educational Statistics, in 2017, 15% of students enrolled in public schools were Black and 27% were Hispanic, which are significantly different from those found in the tables above. So, while there was a significant increase in participation, there is still much progress to be made.

5. Analysis of Passing Rates for Underrepresented Populations: While we have found that participation has significantly increased in both AP CSP and AP CSA for females, Black, and Hispanic students, there is still concern that they are as successful as their white counterparts.

6. Conclusions

7. References:

National Center for Education Statistics. (2022). Racial/Ethnic Enrollment in Public Schools. *Condition of Education*. U.S. Department of Education, Institute of Education Sciences. Retrieved [Nov 27, 2022],from https://nces.ed.gov/programs/coe/indicator/cge.