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ORIGINAL ARTICLE

Advanced Placement Biology Scores: A Comparison of Scores for White and Hispanic Students from California, Texas, and Arizona

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ABSTRACT

The performance of White students and Hispanic students from California, Texas, and Arizona on the advanced placement (AP) biology exam was compared using archival data from the College Board from 2016 through 2019. Pearson Chi-square tests yielded statistically significant differences in all 4 year comparisons of white and Hispanic students in all three states. White students from California had the highest percentage of students earn a 3 or higher for all 4 years, Arizona had the second highest percentage of white students earn a 3 or higher for all 4 years, and Texas had the lowest percentage of white students earn a 3 or higher for all 4 years of comparison. Hispanic students from Arizona had the highest percentage of students earn a 3 or higher for all 4 years, California had the second highest percentage of Hispanic students earn a 3 or higher for all 4 years, and Texas had the lowest percentage of Hispanic students earn a 3 or higher for all 4 years of comparison. It was discovered a majority of White students who took an AP biology exam, from 2016 to 2019, earned a passing score (3 or higher), while the majority of Hispanic students who took an AP Biology exam failed to earn a passing score (3 or higher), that would result in college credit. Implications of these findings are discussed.

KEY WORDS: Advanced placement biology; college board; hispanic students

INTRODUCTION

Quality education has been the primary goal of the educational system in the United States for decades, with the ultimate driving force to produce high school graduates that are able to successfully compete in the global workforce (Sargent, 2017). Unfortunately, American high school students score lower in science, math, and STEM benchmark rates (ACT, 2016), and American high schools have not been adequately preparing students for the 21st century workforce (Allensworth, 2017). Approximately half of American students do not complete high school with a high school diploma, and those that do graduate and advance to college require remedial coursework and many do not graduate from college with a degree (Allensworth, 2017).

The Hispanic population in the United States is projected to increase from 55 million in 2014 to 119 million by the year 2060. This 116% increase will make up approximately 29% of the United States population (Colby and Ortman, 2015). The Hispanic student distribution of enrollment (K-12) in United States public schools was 23.1% in 2010 and increased to 28.0% in 2020 (U.S. Department of Education, 2021). The United States high school student K-12 population changed from 8,708,000 White students in 1999 to 7,230,000 White students in 2020 and a change of 1,815,000 Hispanic students in 1999 to 4,223,000 Hispanic students in 2020 (U.S. Department of Education, 2021). The three states that observed the greatest increase in Hispanic student enrollment was Arizona, 42.2–45.4%, California, 51.4–55.4%, and Texas, 50.3–52.9%, during this same 10 year period (U.S. Department of Education, 2021).

Enrollment in advanced placement (AP) courses has increased over the past two decades and between the years 1996 and 2012, enrollment in AP courses has grown by 291% and the number of administered AP exams has expanded by 338% (Judson and Hobson, 2015), with the greatest growth among Black and Hispanic students, especially in math and science with an annual growth rate in AP test-taking 6 times the average rate of other ethnicities (Judson, 2017). However, the expansion of AP courses into low-income schools has not reflected instructional rigor as evidenced by the revelation that many low-income students earned low AP exam scores while achieving relatively high AP course grades (Hallett and Venegas, 2011).

Growth of STEM AP exam-taking by Hispanic students outpaced White students from 1997 to 2013; however, the pass rate decreased for Hispanic students (–12.2%) while increasing for White students (+2.5%) (Judson, 2017). Hispanic students took STEM AP exams at a rate of 12,901 in 1997 and 132,778 in 2013; a 929.2% increase, while the Hispanic student STEM AP pass rate (3+ score) was 43.4% in 1997 and dropped to 38.1% in 2013 (decrease of 5.3%) (Judson, 2017). Despite the AP recruitment surge, a pass rate gap has occurred between

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traditionally underrepresented students, Hispanic students, and majority peers, White students, (Judson, 2017).

Hispanic students participated in 2017 at more than eight times their rate in 1997 and came close to the rates at white students, and representation of Hispanic/Latino students among AP exam takers closely mirrored their presence in high school students on a national level (Finn and Scanlan, 2020). The pass rates (scores of 3 or higher) dropped more for Hispanic students than the student population. While the number of AP exams taken by Hispanic students rose sixteen-fold, from 1997 to 2017, their success rate fell from 59% to 41%. In contrast, the pass rates for White students remained relatively consistent for this same time period (Finn and Scanlan, 2020). Wide gaps were also found at the other end of the scale for AP exam scores of 4 and 5. Approximately 36% of AP exams taken by White students in 2017 yielded 4s or 5s, compared to 21% for Hispanic students (Finn and Scanlan, 2020).

The AP program was established in 1952, by the College Board, with the primary goal of providing high achieving high school students an opportunity to earn college credit if they passed a subject specific exam at the end of the school year (Warne and Anderson, 2015). Originally created to narrow the gap between secondary and college students, the AP program currently offers 34 AP test exams to more than 2 million students per year, and students must earn a score of 3, 4, or 5 on an AP exam to pass; however, the college board does not award college credit for passing an AP test, and the decision to award college credit is made by the individual college or university (College Board, 2012). However, many colleges and universities only award college credit for a score of 4 or 5 on specific exams (Smith et al., 2017).

Students that passed (score of 3 or higher) AP Biology, AP Chemistry, and AP Physics tests earned higher grades in college introductory science courses than college students that had either no high school course in the subject or a regular high school course. However, in 1st year college chemistry and physics courses, certain non-AP students scored equal college grades in the same course as students that passed the AP exam. While the AP program has advantages, these advantages are not uniform for all students (Sadler and Sonnert, 2010).

The college board surveyed 1200 AP biology teachers on their professional development experiences and their instructional and assessment practices. They found three teacher practices associated with positive AP student performance which included frequency of class meetings, alignment of curricula with AP exam topics, and the proportion of students taking the AP exam. Classes with at least 75% of students completing the AP Biology exam did significantly better than classes with <50% of students sitting for the exam (Paek et al., 2010).

The U.S. education system has been impacted by excellence gaps which include geography, income, and ethnicity, and the AP program has grown over the past 60 years into most U.S. Public and private high schools to provide educational opportunity and upward mobility for disadvantaged students to eradicate the country's excellence gaps (Finn and Scanlan, 2020). The potential benefits of AP courses and exams have led to a five-fold increase in high school students taking AP exams over the last 30 years (College Board, 2020). U.S. high school AP course offerings have increased from 52% in 1997 to 71% in 2017, and an increased number of U.S. public high school students taking AP exams from 7.7% in 1997 to 33.9% in 2017 (Finn and Scanlan, 2020).

Much of the college board's research on the AP program show it to be beneficial for high school students; however, there is the potential for a conflict of interest with college board consultants and scientists researching the potential benefits of the college board AP program for high school students (Warne, 2017). Independent research on the effectiveness of the college board's AP program is crucial to address the potential for bias or conflict of interest from college board researchers (Warne and Anderson, 2015). Many of the college board researcher's studies have controlled for few or no confounding variables which is problematic if a causal relationship cannot be established between AP experience and college success, since policies that just increase the AP courses and test-taking will not improve the college success rates for non-traditional AP students (Klopfenstein and Thomas, 2010). Controlling for covariates reduces the apparent positive impact of the AP program on student academic achievement (Warne et al., 2015). The most important questions about the AP program are regarding whether the AP program provides academic benefits to high school students and if so, what are these specific benefits and how large of an impact do they provide for high school students (Warne, 2017).

The college board (2012) has developed a policy that encourages increased access to AP courses for underrepresented students; specifically, the *AP Equity* and *Access Policy Statement*, that reads:

The college board strongly encourages educators to make equitable access a guiding principle for their AP programs by giving all willing and academically prepared students the opportunity to participate in AP. We encourage the elimination of barriers that restrict access to AP for students from ethnic, racial, and socioeconomic groups that have been traditionally underserved. Schools should make every effort to ensure their AP classes reflect the diversity of their student population. The college board also believes that all students should have access to academically challenging course work before they enroll in AP classes, which can prepare them for AP success. It is only through a commitment to equitable preparation and access that true equity and excellence can be achieved (p. 2).

Statement of the Problem

The low performance of Hispanic students on STEM AP science tests is alarming, and the implication of academic deficiencies for Hispanic students may have far reaching consequences. While the college board has shown explosive growth of underrepresented students taking STEM AP science

tests, the pass rate gap between traditionally underrepresented students and their majority peers cannot be ignored (Judson, 2017). One major concern is the expansion of AP course offerings into low-income schools; however, the evidence of low-income students earning low AP exam scores while achieving relatively high AP course grades is concerning (Hallett and Venegas, 2011). The growth of STEM AP exam-taking by Hispanic and black students outpaced both White and Asian students from 1997 to 2013; however, the pass rate during this time decreased for Hispanic students (–12.2%) and Black students (–8.4%), while increasing for White students (+2.5%) and Asian students (+4.4%) (Judson, 2017).

Student participation in rigorous AP classes in high school is important for increasing college readiness and success for students; unfortunately, wide gaps are found at the end of the scale for AP exam scores of 4 and 5, with approximately 45% of AP exams taken by Asian students in 2017 yielded 4s or 5s, compared to 36% for Whites, 21% for Hispanic students, and only 12% for Black students (Finn and Scanlan, 2020). This disparity has resulted in Hispanic students lagging behind White and Asian student peers in college readiness, college enrollment, academic achievement, and successful completion of college with a degree.

Purpose of the Study

One of the most important predictors of success in college is for high school students to have an academically rigorous high school experience (Adelman, 2006). The AP program provides students with the opportunity to complete college-level courses, while still in high school, and increases the likelihood that students will succeed in college (College Board, 2012). For school leaders to meet the needs of all students, differences in the performance in biology of White and Hispanic students participating in accelerated learning programs was investigated. The purpose of this study was to conduct a comparison between White and Hispanic student exam scores from California, Texas, and Arizona on AP Biology exams. These three states were chosen since they have the largest Hispanic student populations of states within the United States. In particular, the performance of White and Hispanic students on AP biology exams were analyzed, utilizing archival data from the college board, for AP biology exams administered from 2016 to 2019 in these three states.

Significance of the Study

AP coursework represents a rigorous and challenging curricula option for high school students in preparation for the academic rigor of college coursework (Eyring, 2011). While several researchers have studied the gaps in participation rates of traditionally underrepresented students in the AP program, none have compared the performance of Hispanic student performance in AP biology from one state to another. The study of the performance of Hispanic students in AP biology are relevant to educational leaders since the AP program is designed to prepare students for the academic rigors of college coursework. In addition, it is essential to study and understand how Hispanic students, the fastest growing demographic group in the United States, are performing on the AP biology exam.

Differences in Hispanic student achievement on the AP biology exam may be attributed to differences in the educational programs of the three states in this study, California, Texas, and Arizona, which have the fastest growing Hispanic populations in the United States. It is hoped that the findings of this study may be used for the identification and development of best policies and practices related to Hispanic student participation in current and future AP STEM programs. Identifying and developing promising practices and policies related to Hispanic student participation in current and future AP STEM programs.

The theoretical framework for this study is the effectively maintained inequality (EMI) Theory, proposed by Klugman (2013). This theory posits that the expansion of AP programs to lower income students is possible with a targeted effort; however, this effort is often countered by additional growth among upper-middle class students due to higher expectations and parental pressure (Judson, 2017). The EMI theory may be supported by the incredible expansion in AP test-taking while the gap in achievement raises whether inequalities are intensified (Judson, 2017).

Research Questions

For this study of performance of White and Hispanic students from California, Texas, and Arizona on AP biology exams, two research questions were addressed for each of the 4 years of data available from 2016 to 2019.

Research question 1

To what extent, if any, was there a statistically significant difference in the performance of White students on the AP biology exam as a function of state residency (i.e., Texas, California, and Arizona)?

Research question 2

To what extent, if any, was there a statistically significant difference in the performance of Hispanic students on the AP biology exam as a function of state residency (i.e., Texas, California, and Arizona)?

METHODS

Archival data from the administration of AP exams for White and Hispanic students living in California, Texas, and Arizona between 2016 and 2019 were obtained for this investigation. This was the most current pre-COVID data available. Four years of archival data were acquired from the college board website. The website includes an excel file for every year and for each state containing student participation and performance on AP biology exams. The data were separated by gender, ethnicity, and grade level.

RESULTS

The purpose of this study was to compare the performance of White and Hispanic students from California, Texas, and

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Arizona on AP biology exams. Data for the 4 years from 2016 through 2019 were analyzed. A series of 3 (state of residency) × 5 (AP exam score) Chi-square procedures were conducted to examine the relationship between the variables. Specifically, Pearson Chi-square tests were utilized to ascertain whether statistically significant differences in AP biology exam score distributions were present among the three states: California, Texas, and Arizona.

Research Question 1

For the first research question, the focus was on comparing the performance of White students from California, Texas, and Arizona on the AP biology exam for each test administration from 2016 to 2019. Frequencies and percentages of overall exam scores for white students from California, Texas, and Arizona for the 2016 through 2019 test administrations are included in Table 1.

For the 2016 test administration, the result was statistically significant, χ^2 (8, n = 18.036) = 133.65, p < 0.001, Cramer's V = 0.06, a trivial effect size (Cohen, 1992). In general, California (74.74%) had a greater percentage of White students who earned a score of 3 or higher than did Arizona (72.53%) and Texas (68.69%) (Table 2).

Regarding the 2017 test administration, differences in AP biology exam scores earned by White students from California, Texas, and Arizona were statistically significant, χ^2 (8, n = 18.864) = 154.05, p < 0.001, Cramer's V = 0.06, a trivial effect (Cohen, 1992). A substantially higher percentage of White students from California (76.72%) earned a score of 3 or higher, compared with Arizona (76.38%) and Texas (71.30%) (Table 2).

For the 2018 AP biology test administration, results were again statistically significant, χ^2 (8, n = 18.847) = 358.77, p < 0.001, Cramer's V = 0.10, small effect size (Cohen, 1992). In 2018, 76.18% of White students from California who took the AP Biology exam earned a score of 3 or higher compared with 70.15% from Arizona and 65.83% from Texas (Table 2).

For the 2019 AP biology test administration, the result was statistically significant, χ^2 (8, n = 18.947) = 307.22, p < 0.001, Cramer's V = 0.09, trivial effect size (Cohen, 1992). A larger percentage of White students from California (77.97%) earned scores of 3 or higher compared with Arizona (77.04%) and Texas (69.04%) (Table 2).

For all 4 years of comparison, California had the highest percentage of White students earn a score of 3 or higher on the AP biology exam scores (Table 2). Texas had the lowest percentage of White students earn a score of 3 or higher for two of the 4 years (2016 and 2017) and Arizona had the lowest percentage of White students earn a score of 3 or higher for the other 2 of 4 years (2018 and 2019) (Table 2). Moreover, the practical significance was determined by examining effect sizes as measured by Cramer's V as shown in Table 3. Effect sizes for all years were either trivial or small and varied from a low of 0.06 to a high of 0.10. Moreover, the effect sizes for the differences were small and reflective of small differences in percentages of White students earning scores of 3 or higher. Readers should note that even though the effect size differences were small and reflective of small differences in percentages of white students earning scores of 3 or higher, these percentages were reflective of hundreds of students.

Table 4 includes the number of White students who took the AP biology exam from California, Texas, and Arizona. The

Table 1: Frequencies and percentages of advanced placement biology exam scores for white students for the 2016 through the 2019 test administrations

Year	Exam score	California	Texas	Arizona
		n (%)	n (%)	n (%)
2016	5	895 (8.95)	425 (6.50)	101 (6.76)
	4	2.790 (27.89)	1.545 (23.62)	393 (26.32)
	3	3.791 (37.90)	2.523 (38.57)	589 (39.45)
	2	2.152 (21.52)	1.645 (25.15)	342 (22.91)
	1	374 (3.74)	403 (6.16)	68 (4.55)
2017	5	793 (8.01)	415 (5.53)	113 (7.73)
	4	2.682 (27.11)	1.682 (22.40)	425 (29.09)
	3	4.116 (41.60)	3.257 (43.37)	578 (39.56)
	2	2.022 (20.44)	1.815 (24.17)	297 (20.33)
	1	281 (2.84)	340 (4.53)	48 (3.29)
2018	5	992 (10.39)	458 (5.78)	124 (8.99)
	4	2.752 (28.83)	1.882 (23.76)	340 (24.64)
	3	3.528 (36.96)	2.875 (36.29)	504 (36.52)
	2	1.959 (20.52)	2.147 (27.10)	339 (24.57)
	1	314 (3.29)	560 (7.07)	73 (5.29)
2019	5	870 (9.22)	461 (5.69)	136 (9.64)
	4	2.775 (29.40)	1.901 (23.48)	397 (28.14)
	3	3.714 (39.35)	3.228 (39.87)	554 (39.26)
	2	1.808 (19.15)	2.022 (24.97)	271 (19.21)
	1	272 (2.88)	485 (5.99)	53 (3.76)

Table 2: Percentage of white students who earned a 3 or higher score on the advanced placement biology exam by state from 2016 to 2019

Year	California (%)	Texas (%)	(Arizona) %
2016	74.74	68.69	72.53
2017	76.72	71.30	76.38
2018	76.18	65.83	70.15
2019	77.97	69.04	77.04

Table 3: Effect sizes for the comparison of advanced placement biology exam scores for white students from 2016 to 2019

Year	Cramer's *V*	Effect size
2016	0.06	Trivial
2017	0.06	Trivial
2018	0.10	Small
2019	0.09	Small

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number of White students who took the AP biology exam in each of the three states remained relatively consistent during the 4 year period. Specifically, Arizona had a consistent rate from 1493 students who took the AP biology exam in 2016 to 1411 students who took the exam in 2019. Similarly, the number of White examinees who took the AP biology exam in California remained consistent from 10,002 students who took the exam in 2016 to 9439 students in 2019. Finally, Texas had a slight increase in participation of 6,541 students who took the exam in 2016 to 8,097 students who took the exam in 2019.

Another statistic used to compare the performance of White students from California, Texas, and Arizona was the mean exam score. The mean scores on the AP biology exam for White students from California, Texas, and Arizona for each year from 2016 to 2019 are depicted in Table 5. From 2016 until 2019, White students from California earned the highest mean score on the AP Biology exam for all years, except 2017, when compared with White students from California and Texas. White students from Arizona earned lower mean scores for three of the 4 years of comparison (2016, 2018, and 2019); however, Arizona White students had the highest mean score during 2017. White students from Texas earned the lowest mean scores for all 4 years (Table 5). The mean scores earned by White students from California, on the AP Biology exam, gradually increased from 2016 to 2019. In contrast, the mean scores for White students from Arizona, on the AP Biology exam, gradually increased from 2016 to 2017, dipped lower in 2018, and then spiked again in 2019. White students in Texas showed a slight increase, on AP Biology exams, from 2016 to 2017, and then leveled off in 2018 and 2019. For example, the mean score ranged from a high of 3.17 in 2016 to a low of 2.94 in 2019 for White students in all three states (Table 5).

Research Question 1 sought to determine whether there was a statistically significant difference in the performance of White students on the AP biology exams a function of state residency (i.e., California, Texas, and Arizona)? The Pearson Chi-square tests showed a statistically significant difference between the AP Biology exam performance of White students from the states of California, Texas, and Arizona; therefore, the null hypothesis was rejected and the alternative hypothesis was accepted that there was a statistically significant difference between the AP Biology exam performance of White students from these three states.

Table 4: Number of white students who took the advanced placement biology exam by state from 2016 to 2019

Year	California *(n)*	Texas *(n)*	Arizona *(n)*
2016	10.002	6.541	1.493
2017	9.894	7.509	1.461
2018	9.545	7.922	1.380
2019	9.439	8.097	1.411

Table 5: Means of advanced placement biology exam scores for white students by state from 2016 to 2019.

Year	California (M)	Texas (M)	Arizona (M)
2016	3.17	2.99	3.08
2017	3.17	3.00	3.18
2018	3.23	2.94	3.07
2019	3.23	2.98	3.21

Table 6: Frequencies and percentages of advanced placement biology exam scores for Hispanic students for the 2016 through the 2019 test administrations

Year	Exam score	California	Texas	Arizona
		n (%)	n (%)	n (%)
2016	5	192 (1.57)	82 (1.04)	16 (1.79)
	4	924 (7.54)	545 (6.94)	89 (9.97)
	3	2.848 (23.24)	1.659 (21.11)	236 (26.43)
	2	5.073 (41.40)	3.180 (40.47)	388 (43.45)
	1	3.216 (26.25)	2.392 (30.44)	164 (18.37)
2017	5	160 (1.23)	93 (0.94)	18 (1.95)
	4	967 (7.41)	608 (6.17)	106 (11.51)
	3	3.319 (25.44)	2.451 (24.88)	271 (29.42)
	2	5.709 (43.75)	4.215 (42.79)	363 (39.41)
	1	2.893 (22.17)	2.484 (25.22)	163 (17.70)
2018	5	244 (1.91)	120 (1.11)	20 (1.89)
	4	1.119 (8.75)	728 (6.74)	108 (10.22)
	3	2.968 (23.21)	2.354 (21.79)	253 (23.94)
	2	5,122 (40.05)	4.403 (40.76)	413 (39.07)
	1	3.335 (26.08)	3.197 (29.60)	263 (24.88)
2019	5	192 (1.49)	125 (1.15)	19 (1.82)
	4	1.198 (9.28)	797 (7.34)	100 (9.57)
	3	3.380 (26.19)	2.547 (23.47)	312 (29.86)
	2	5.234 (40.55)	4.428 (40.80)	395 (37.80)
	1	2.902 (22.49)	2.956 (27.24)	219 (20.96)

Research Question 2

For the second research question, the focus was on comparing the performance of Hispanic students from California, Texas, and Arizona on the AP biology exam for each test administration from 2016 through 2019. Frequencies and percentages of overall exam scores for Hispanic students from California, Texas, and Arizona for the 2016 through 2019 test administrations are included in Table 6.

For the 2016 test administration, the result was statistically significant, χ^2 (8, n = 21.004) = 97.98, p < 0.001, Cramer's V = 0.05, a trivial effect size (Cohen, 1992). In general, Arizona (38.19%) had a greatest percentage of Hispanic students who earned a score of 3 or higher than did California (32.35%) and Texas (29.09%) (Table 7).

Regarding the 2017 test administration, differences in AP Biology exam scores earned by Hispanic students from California, Texas, and Arizona were statistically significant, χ^2 (8, n = 23.820) = 95.05, p < 0.001, Cramer's V = 0.04, a trivial effect (Cohen, 1992). A substantially higher percentage

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of Hispanic students from Arizona (42.88%) earned a score of 3 or higher, compared with California (34.08%) and Texas (31.99%) (Table 7).

For the 2018 AP biology test administration, results were again statistically significant, χ^2 (8, n = 24.647) = 98.17, p < 0.001, Cramer's V = 0.04, trivial effect size (Cohen, 1992). In 2018, 36.05% of Hispanic students from Arizona who took the AP biology exam earned a score of 3 or higher compared with 33.87% from California and 29.64% from Texas (Table 7).

For the 2019 AP biology test administration, the result was statistically significant, χ^2 (8, n = 24.804) = 123.48, p < 0.001, Cramer's V = 0.05, trivial effect size (Cohen, 1992). A larger percentage of Hispanic students from Arizona (41.25%) earned scores of 3 or higher compared with California (36.96%) and Texas (31.96%) (Table 7).

For all 4 years of comparison, Arizona had the highest percentage of Hispanic students earn a score of 3 or higher on the AP biology exam scores, California came in second and Texas came in last for all 4 years of comparison (Table 7). Moreover, the practical significance was determined by examining effect sizes as measured by Cramer's V as shown in Table 8. Effect sizes for all 4 years were trivial and varied from a low of 0.04 to a high of 0.05. Readers should note that even though the effect size differences were trivial and reflective of small differences in percentages of Hispanic students earning scores of 3 or higher, these percentages were reflective of hundreds of students.

Table 9 includes the number of Hispanic students who took the AP biology exam from California, Texas, and Arizona. The number of Hispanic students who took the AP Biology exam in each of the three states remained relatively stable during the 4 year period. Specifically, California had a consistent rate from 12.253 students who took the AP biology exam in 2016 to 12.906 students who took the exam in 2019. Similarly, the number of Hispanic examinees who took the AP biology exam in Texas increased from 7.858 students who took the exam in 2016 to 10.853 students in 2019. Finally, Arizona had a consistent rate of participation from 893 students who took the exam in 2016 to 1.045 students who took the exam in 2019.

Another statistic used to compare the performance of Hispanic students from California, Texas, and Arizona was the average exam score. The average scores on the AP biology exam for Hispanic students from California, Texas, and Arizona for each year from 2016 to 2019 are depicted in Table 10. From 2016 to 2019, Hispanic students from Arizona earned the highest average score on the AP biology exam, for all 4 years, when compared with Hispanic students from California and Texas. However, Hispanic students from California outperformed their peers from Texas for all 4 years. Hispanic students from Texas earned the lowest average score for all 4 years of comparison. In general, the average scores earned by Hispanic students from California and Texas on the AP biology exam gradually increased for all 4 years. In contrast, the average scores for Hispanic students from Arizona on the AP biology exam have varied considerably during this period, with an increase from 2016 to 2017, to a slight decrease in 2018, and a slight increase in 2019.

Table 7: Percentage of Hispanic students who earned a 3 or higher score on the advanced placement biology exam by state from 2016 to 2019

Year	California (%)	Texas (%)	Arizona (%)
2016	32.35	29.09	38.19
2017	34.08	31.99	42.88
2018	33.87	29.64	36.05
2019	36.96	31.96	41.25

Table 8: Effect Sizes for the comparison of advanced placement biology exam scores for Hispanic Students from 2016 to 2019

Year	Cramer's *V*	Effect size
2016	0.05	Trivial
2017	0.04	Trivial
2018	0.04	Trivial
2019	0.05	Trivial

Table 9: Number of Hispanic students who took the advanced placement biology exam by state from 2016 to 2019

Year	California (n)	Texas (n)	Arizona (n)
2016	12.253	7.858	893
2017	13.048	9.851	921
2018	12.788	10.802	1.057
2019	12.906	10.853	1.045

Table 10: Means of advanced placement biology exam scores for Hispanic students by state from 2016 to 2019

Year	California (M)	Texas (M)	Arizona (M)
2016	2.17	2.08	2.34
2017	2.22	2.15	2.41
2018	2.20	2.09	2.25
2019	2.27	2.14	2.33

Research question 2 sought to determine whether there was a statistically significant difference in the performance of Hispanic students on the AP biology exams a function of state residency (i.e., California, Texas, and Arizona)? The Pearson Chi-square tests showed a statistically significant difference between the AP biology exam performance of Hispanic students from the states of California, Texas, and Arizona; therefore, the null hypothesis was rejected and the alternative hypothesis was accepted that there is a statistically significant difference between the AP biology exam performance of Hispanic students from these three states.

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DISCUSSION

The college board (2012) has supported making AP courses accessible to all students that are willing and academically prepared, while eliminating any barriers that might restrict access to AP for any students. Providing access to academically challenging courses before enrolling in AP classes can prepare students for success in AP courses. The college board supports equitable access and preparation to bring about excellence and true equity for all students. One of the problems facing the rapid expansion of AP course offerings in low-income schools, with traditionally underrepresented students, has been a lack of instructional rigor as demonstrated by many underrepresented students earning low AP exam scores while achieving relatively high AP course grades (Hallett and Venegas, 2011).

Hispanic students participated in 2017 at more than eight times their rate in 1997 and came close to the rates at white students, and representation of Hispanic/Latino students among AP exam takers closely mirrored their presence in high school students on a national level (Finn and Scanlan, 2020). The pass rates (scores of 3 or higher) dropped more for Hispanic students than the student population. While then number of AP exams taken by Hispanic students rose sixteen-fold, from 1997 to 2017, their success rate fell from 59% to 41%. In contrast, the pass rates for White students remained relatively even with Asian students pass rates rising (Finn and Scanlan, 2020). Wide gaps were also found at the other end of the scale for AP exam scores of 4 and 5. Approximately 45% of AP exams taken by Asian students in 2017 yielded 4s or 5s, compared to 36% for White students, 21% for Hispanic students, and 12% for Black students (Finn and Scanlan, 2020).

High school students completing AP coursework is a challenging and rigorous option in preparation for the challenges of college coursework (Eyring, 2011). While several researchers have studied gaps in participation rates of traditionally underrepresented students in the AP program, no study has compared Hispanic student performance in AP biology from one state to another. The study of the performance of Hispanic students in AP biology should be relevant to educational leaders since the AP program is designed to prepare students for the academic rigors of college coursework. Specifically, it is essential to study and understand how Hispanic students, the fastest growing demographic group in the United States, are performing on the AP Biology exam.

Differences in Hispanic student achievement on the AP biology exam may be attributed to differences in the educational programs of the three states in this study, California, Texas, and Arizona. It is hoped that the findings of this study may be used for the identification and development of best policies and practices related to Hispanic student participation in current and future AP STEM programs.

The theoretical framework for this study was the EMI Theory, proposed by Klugman (2013). This theory posits that the expansion of AP programs to lower income students is possible with a targeted effort; however, this effort is often countered by additional growth among upper-middle class students due to higher expectations and parental pressure (Judson, 2017). The EMI theory may be supported by the incredible expansion in AP test-taking while the gap in achievement raises whether inequalities are intensified (Judson, 2017).

This study discovered that a majority of White students who took an AP Biology exam, from 2016 to 2019, earned a passing score (3 or higher), while the majority of Hispanic students who took an AP Biology exam failed to earn a passing score (3 or higher), that would result in college credit. Specifically, dramatic increases in the number of Hispanic students who took AP Biology exams in each of the three states were documented in this current study, with the number of Hispanic students taking the AP Biology exam matched or exceeded the number of White students taking the same test for the comparison years. In addition, the overall scores earned by White students generally increased during this 4 year period, while the majority of Hispanic students who took AP Biology exams in California, Texas, and Arizona from 2016 through 2019 did not attain passing scores (3 or higher) that would result in college credit or placement. These findings support the EMI theory that despite increased numbers of underrepresented students taking the AP biology exam, White students performed better than Hispanic students, on the same standardized AP biology exam, which intensified the achievement gap and revealed further inequalities between the two groups.

Implications

Theoretical implications

While the AP program has grown over the past 60 years with the purpose of providing educational opportunities and upward mobility for underrepresented students, the excellence gap has not been narrowed as evidenced by the findings of this study. AP exams are standardized and administered to high school students in the month of May. The number of White and Hispanic students that took the AP biology exam in this study was comparable; however, student performance revealed significant performance gaps between the two groups. The average percentage of White students who earned a 3 or higher on the AP Biology exam for the 4 years of comparison was California (76.40%), Arizona (74.03%), and Texas (68.72%) (Table 2). The average means of White students on the AP biology exam for the same 4 years of comparison was California (3.20), Arizona (3.14), and Texas (2.98) (Table 5). The average percentage of Hispanic students who earned a 3 or higher on the AP Biology exam for the 4 years of comparison was California (34.32%), Arizona (39.59%), and Texas (30.67%) (Table 7). The average means of Hispanic students on the AP Biology exam for the same 4 years of comparison was California (2.22), Arizona (2.33), and Texas (2.12) (Table 10). It is important to note that all Pearson Chi-square tests were statistically significant, for both White and Hispanic students in all 4 years of comparison. White students earned a 3 or higher on the 2016–2019 AP biology exams at a percentage at least double their Hispanic peers. White students also earned almost

a full one-point higher average mean than Hispanic students on the same AP biology exams.

Practical implications

The practical significance was determined by examining effect sizes as measured by Cramer's *V* as shown in Table 3 for White students. Effect sizes for all years were either trivial or small and varied from a low of 0.06 to a high of 0.10 (Table 3). Moreover, the effect sizes for the differences were small and reflective of small differences in percentages of White students earning scores of 3 or higher. The practical significance was determined by examining effect sizes as measured by Cramer's *V* as shown in Table 8 for Hispanic students. Effect sizes for all years were trivial and varied from a low of 0.04 to a high of 0.05 (Table 8). Moreover, the effect sizes for the differences were trivial and reflective of differences in percentages of Hispanic students earning scores of 3 or higher. Readers should note that even though the effect size differences were either trivial or small and reflective of small differences in percentages of both White and Hispanic students earning scores of 3 or higher, these percentages were reflective of hundreds of students.

CONCLUSION

The most important question about the college board's AP program should be whether the AP program provides academic benefits to every high school student and if so, what are the specific benefits and how large of an impact might they provide for high school students (Warne, 2017). The mission of the college board to provide access to AP for all students is to be commended; however, the placement of underprepared students in AP courses is problematic if a causal relationship cannot be found between high school student's AP experience and success in college, since practices that just increase the number of AP course offerings and AP test-taking will not improve the college success of traditionally underrepresented students (Klopfenstein and Thomas, 2010).

Many of the college board researcher's studies have controlled for few or no confounding variables, which may reduce the positive impact of the AP program on student academic achievement (Warne et al., 2015). The results of this study revealed a large significant difference between the performance of White and Hispanic students on the AP Biology exam for the 2016–2019 academic years. The cause or causes for this disparity requires additional analysis into how each of the three states in this study developed and implemented their AP biology programs of study. Educational leaders and practitioners should examine prerequisite curriculum to determine whether proper alignment exists between developing skills and specific knowledge necessary for student success in the most rigorous placement (Moore and Slate, 2010), including AP STEM courses like AP biology.

CONFLICTS OF INTEREST

There are no conflicts of interest to declare.

ETHICAL STATEMENT

As this paper used only previously published archival data and did not include any individuals, no ethical standards were violated.

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