

# Grade-level Participation in the AP Curriculum

Adway S. Wadekar  
Westborough High School, Westborough, MA 01581  
adway@adway.us

**Abstract** – Since its inception in 1955, the Advanced Placement (AP) curriculum has grown and evolved -- both in terms of the number of subjects and the number of students attempting the AP tests. Students take AP classes to position themselves better for college admissions, to earn college credit, or to simply pursue their passion and interest. Although the AP program is designed primarily for high school students, participation among the younger students has increased over the years. In this paper, I seek to understand the participation in the different AP subjects among high school and pre- high school students. I analyze the data published by the College Board from the May 2016 AP examination made available on Kaggle. I divide the AP subjects into six categories as suggested by the College Board, and compute the preferences for the subjects in each category for four grades of high school and a single group of pre- high school students. I find that the preferences for AP subjects vary dramatically through the four years of high school. Moreover, the preferences in the pre- high school group are definitively different from the four high school grades; with younger students choosing more difficult subjects. I conclude the paper by providing detailed insights into these observations and their implications.

*Index Terms* – Advanced Placement, College Board, Grade-level, High School, Pre High School.

## INTRODUCTION & MOTIVATION

The Advanced Placement (AP) program is created and run by the College Board, and it consists of standardized high school courses, roughly equivalent to undergraduate college courses [1]. Students take these AP classes in high school and earn a passing grade to serve two purposes. First, it offers them a competitive advantage in the college admissions process. Second, it can earn them college credit and accelerated placement, thereby reducing some financial burden of attending college. Over the years, the AP program has evolved (traditional subjects split into more nuanced ones – such as Math split into Calculus AB, Calculus BC, and Statistics), and grown (new courses have been added to reflect the changing times and contemporary issues, including Computer Science and Environmental Science). It has also increased in volume; the number of students taking AP classes has grown steadily over the years [2].

Given this growing popularity of the AP program, I wanted to understand how the participation of the students in

the different AP subjects varies according to the grade levels. Moreover, while the AP program is primarily recommended for high school students, it is becoming increasingly common, especially, among high achieving middle school students to take AP classes earlier, even before they enter high school. Therefore, I also wanted to know if the preferences for AP subjects differ among these younger students compared to those in high school. To understand these preferences, I analyzed the data published by the College Board from the May 2016 AP examination. In this paper, I present my analysis, observations, and detailed insights.

The paper is organized as follows: Section 2 presents my analysis approach. Section 3 summarizes and offers insights into my observations. Section 4 provides an overview of related research. Section 5 concludes the paper and offers direction for future work.

## ANALYSIS APPROACH

I used the data published by the College Board from the May 2016 AP examination. I downloaded this data from the Kaggle data science community [3]. The data consists of two tables. The table *students.csv* reports the number of students taking the AP test for each subject, split according to the demographic variables of grade, gender, and ethnicity. It also lists the number of schools offering each AP subject. The table *exams.csv* reports the distribution of scores, for the various demographic groups for each AP subject. I only used the data in the *students.csv* table, reported according to the grade levels. I considered four grades in high school (9<sup>th</sup> through 12<sup>th</sup>), and the fifth group consisted of students that are not in high school. I presumed that most students that belong to “not in high school” group are younger than the conventional high school students. I also grouped the AP subjects into six areas, as suggested by the College Board [4]. These areas and their constituent subjects include:

- **AP Arts** – Art History, Music Theory, Studio Art: Drawing, Studio Art: 2D Design, Studio Art: 3D Design.
- **AP Science** – Biology, Chemistry, Environmental Science, Physics 1, Physics 2, Physics C: Mechanics, Physics C: Electricity and Magnetism.
- **AP Math & Computer Science** – Calculus AB, Calculus BC, Computer Science A, Statistics.
- **AP History & Social Studies** – Macroeconomics, Microeconomics, European History, Government & Politics: Comparative, Government & Politics: US,

Human Geography, Psychology, US History, World History.

- **AP World Languages & Cultures** – Chinese Language & Culture, French Language & Culture, German Language & Culture, Italian Language & Culture, Japanese Language & Culture, Latin, Spanish Language, Spanish Literature.
- **AP English** – English Language & Composition, English Literature & Composition.

While most of the subjects are self-evident from the titles, I further explored Calculus, Physics, Spanish, English, and Government to understand the subtle differences between the more refined offerings. Calculus AB is equivalent to one semester of college calculus, and BC is equivalent to two semesters [5,6]. Both Physics 1 and Physics 2 are algebra-based - broadly Physics 1 covers Newtonian Mechanics, and Physics 2 covers Electricity and Magnetism. This is the same distinction in the two Physics C courses, except that Physics C courses are calculus-based [7,8,9,10]. Spanish Language is focused on building proficiency in the language [11], whereas, Spanish Literature is focused on critical analysis of the works written by Spanish, Latin American and U.S. Latino authors [12]. U.S. Government and Politics covers the underpinnings of the U.S. political system and processes [13], whereas, Comparative Government and Politics explores politics and societies from countries around the world [14]. English Language seeks to strengthen the effectiveness of writing by applying different strategies, and to cultivate critical reading skills in various non-fiction styles [15]. English Literature explores and evaluates literary works from different genres and periods [16].

After grouping the subjects into six categories, I computed the distribution across subject areas, and then for the specific subjects within each subject area. I computed these distributions for four grades of high school and one group of pre- high school students. Subsequently, I analyzed these distributions to understand the students' preferences for the various subject areas and the specific subjects within these areas.

## RESULTS & DISCUSSION

In this section, I discuss the results and also offer some insights and rationale into the observations gathered by analyzing the distributions. First, I present the preferences for the broad subject areas, and then I dig deeper into the preferences for specific subjects within each area.

**AP Subject Areas:** Figure 1 shows the grade-wise distribution for the six subject areas. History and Social Studies subjects are considerably more popular among 9<sup>th</sup> grade students, and account for about 85% of the tests. This subject area continues to dominate among the 10<sup>th</sup> graders, but now accounts for only 73% of the tests, with the Science subject area coming in at a distant second at about 11%. The tide starts to turn towards other subject areas in the 11<sup>th</sup> grade, and social studies subjects account for only about

35% of the tests. Specifically, English accounts for about 29%, and Sciences rise to approximately 20%. Thus, the distribution of AP subject areas is more balanced among Social Sciences, Hard Sciences, and English in the 11<sup>th</sup> grade. The subject areas are re-balanced again in the 12<sup>th</sup> grade; Math/CS subjects see a significant uptick, coming in second after social studies. English APs lose their second spot to Math/CS subjects among seniors, but Science subjects stay stable at about 20%. Both the Arts and World Language APs rise steadily through high school, but they account for only about 5% even at their peak in the 12<sup>th</sup> grade. The distribution is completely different and balanced in the pre- high school group; Math subjects at 38%, Social Sciences at 30%, and Sciences at 23%.

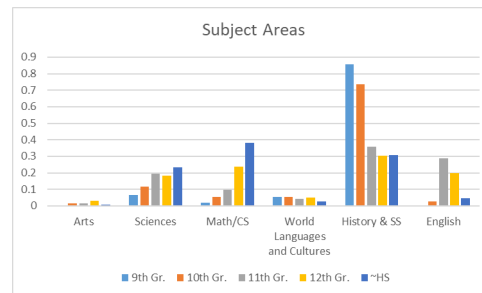


Fig. 1 – Distribution of Subject Areas

**AP Arts:** Figure 2 shows the distribution of the four AP Arts subjects across the different grade levels. The distribution shows that Art History is the most preferred subject until the 11<sup>th</sup> grade. In fact, the likelihood of Art History peaks in the 10<sup>th</sup> grade, and it accounts for about 48% of the AP tests in the Arts group at this grade level. Among 12<sup>th</sup> graders, however, Studio Art 2D Design displaces Art History as the most preferred choice. The preference for Studio Art 3D design and Studio Art Drawing rises consistently across grades. However, although Drawing reaches to 10-12% among seniors; 3D design reaches only 4%. Overall, Music Theory, Art History, and Studio Art 2D design account for about 90-95% of the tests in this group. Among early AP students, the percentage favoring Art History and Music Theory is similar to that of the 9<sup>th</sup> graders. However, between the remaining three Studio Arts courses, 9<sup>th</sup> graders overwhelmingly favor 2D design, whereas the younger students show balance between the three Studio Arts courses. Generally, 2D Design may be one of the easier APs in this group, which may explain its popularity among 9<sup>th</sup> and 12<sup>th</sup> graders. Students in the 9<sup>th</sup> grade may want to initially experiment with one of the easier AP subjects, and those at the end of their high school careers may wish to acquire some quick AP credit.

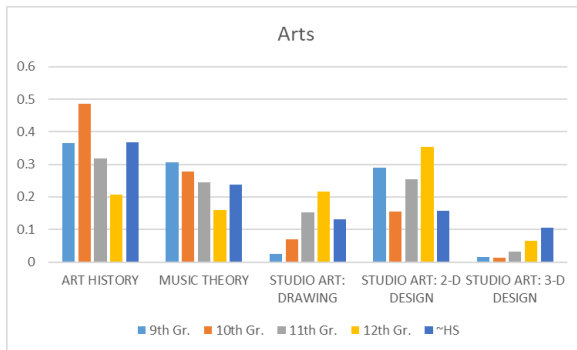


Figure 2: Distribution of Arts Subjects

**AP Science:** Exploring the distribution of AP Science subjects in Figure 3, I found that Environmental Science is the most popular AP subject among the 9<sup>th</sup> graders, perhaps because it is one of the few subjects that can be taken without many pre-requisites [17]. Biology comes in close second among freshman. A much smaller percentage prefer Physics 1, but the other three science subjects receive very little attention. Moving on to the 10<sup>th</sup> grade, Biology becomes the most preferred subject, and Environmental Science significantly loses its luster. Moving along further, high school juniors prefer Biology, Physics 1 and Chemistry nearly equally, and Environmental Science stays steady as it was among sophomores. Finally, Biology regains its popularity among high school seniors, and the four subjects that are nearly balanced behind Biology include Physics 1, Physics: Mechanics, Chemistry and Environmental Science. A surprise, sudden uptick in the popularity of Mechanics occurs in the senior year. This uptick could occur because Mechanics requires a strong foundation in Calculus or at least a concurrent enrollment, which many students cannot acquire until their junior year. In fact, seniors seem to be equally split between Physics 1 and Physics C, perhaps because it is difficult for the students to assess the various Physics offerings to figure which one(s) best suit their interests and college objectives. The distribution of Science subjects in the pre-high school group is once again different. In this group, Physics C: Mechanics and Chemistry are the most popular, with other Physics offerings being distant. Environmental Science is the least popular among younger students. Thus, in summary, Biology earns the distinction of being the most popular AP Science subject in high school, students are balanced between Physics 1 and Chemistry, Environmental Science stays around 20%, and the interest in Physics C: Mechanics gradually rises and peaks in the senior year. It is interesting that the emergent and urgent interest in climate change and sustainability does not translate into higher popularity of Environmental Science.

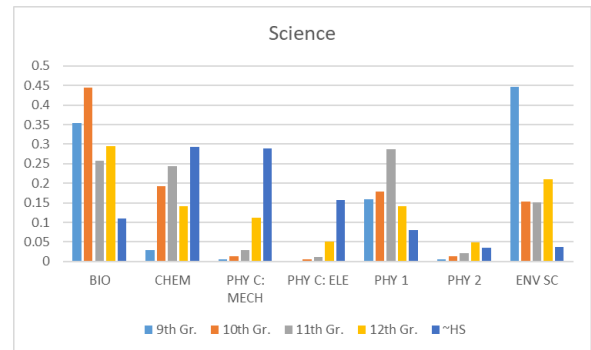


Figure 3: Distribution of Science Subjects

**AP Math & CS:** Figure 4 shows the popularity of AP Math & CS subjects across grades. Unlike the AP Arts and AP Science areas, the percentages are more homogeneous across the four subjects in this area. The percentage for AP Computer Science is the highest in the 9<sup>th</sup> grade, and drops steadily, reaching its lowest point in the 12<sup>th</sup> grade. This could occur because those students with a strong interest and background in programming may choose to take AP CS early on in high school. Contrary to CS, the preferences for both Calculus AB and BC rise steadily through the four years of high school, reaching its peak among seniors. Calculus is generally perceived to be difficult, and hence, students may defer it until their junior year. Moreover, Calculus BC, always remains less popular compared to Calculus AB across all four years, because it is believed to be more intense and fast paced, and is of interest only to engineering and physical sciences majors. The popularity of AP Statistics waxes and wanes, that is, it rises among sophomores and seniors, but is lower among freshmen and juniors. AP Statistics may be accessible to many sophomores after they complete the pre-requisite of Algebra II in their freshman year. Calculus, on the other hand, cannot be taken until the students have completed pre-calculus after Algebra II. In this group, the distribution among early AP students is very similar to that of high school seniors. Thus, in the pre-high school group, students who excel at mathematics may gravitate towards Calculus AB. Finally, since AP CS expects a pre-requisite programming background which many students do not possess, overall it may be the least popular subject in this area.

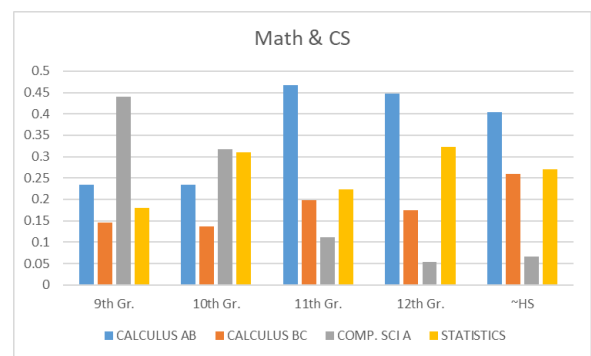


Figure 4: Distribution of Math &amp; CS Subjects

**AP World Languages & Culture:** Figure 5 shows the distribution of AP courses in the World Languages subject area. The figure clearly indicates that Spanish Language is overwhelmingly the most favorite subject in this area across all grades. In fact, Spanish Language garners more than 65% of the share all the way through the junior year. In the senior year, its share drops to slightly below 60% because it cedes some of its popularity to French Language and Culture. This popularity of Spanish Language could be driven in part by the growing Hispanic and Latino population in the U.S. Moreover, the emergence of Spanish as the *de facto* second language could prompt an interest from students from other ethnic groups as well. Although the popularity of Spanish Literature is higher than German, Italian, Japanese and Latin, it is still significantly lower than Spanish Language. Chinese Language is somewhat popular among 9<sup>th</sup> graders and younger students, but it drops through high school, suggesting that mostly only those students whose families speak Chinese choose this subject, and they prefer to do so earlier rather than later in high school.

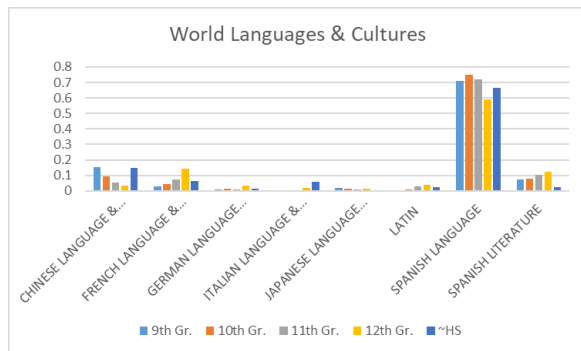


Fig. 5: Distribution of Languages & Cultures Subjects

**AP History & Social Studies:** The distribution of AP subjects in the History & Social Studies group, shown in Figure 6, shows wild swings, yet a clear winner, with a lopsided margin emerges at each grade level. These winners are: Economics among pre- high school students, Human Geography in grade 9, World History in grade 10, U.S. History in Grade 11, and U.S. Government in Grade 12. Beyond these clear winners, the swings in the popularity are dramatic. Human Geography takes a deep dive from 9<sup>th</sup> to 10<sup>th</sup> grade, 9<sup>th</sup> graders may take this course because it may be the only one available to them coming from middle school without any pre-requisites, as suggested by many popular blogs including prepscholar [17]. As a result, when the other courses become available to them in the 10<sup>th</sup> grade, their preference for Human Geography drops dramatically. European History jumps from 9<sup>th</sup> to 10<sup>th</sup> grade and then drops again, U.S. Government and Politics jumps from 11<sup>th</sup> to 12<sup>th</sup> grades, U.S. History jumps in the 11<sup>th</sup> grade and then drops again dramatically, and Psychology jumps from 10<sup>th</sup> to 11<sup>th</sup> grades, and shows a further increase in the 12<sup>th</sup> grade. The least popular subject in this group is Comparative Government and Politics, and it accounts for only 2.5% of the share. In all the grades up to and including the junior

year, both Economics courses are preferred nearly equally. However, in the senior year, the percentage favoring Macroeconomics is nearly double the percentage taking Microeconomics. As students reach their senior year, they may become increasingly cognizant of world dynamics, causing a rise in this interest. Moreover, they may want to explore Economics, but may be able to fit only one in their schedule. Both Economics subjects are the ones favored by pre- high school students; it is interesting to note that in this group only the Economics subjects require mathematical inclination. Overall, these observations suggest that it is difficult to find trends in students' interests in the various subjects in this group. However, the preferences in this group may be driven more by what the students are eligible to take because they have satisfied the pre-requisites rather than genuine interest.

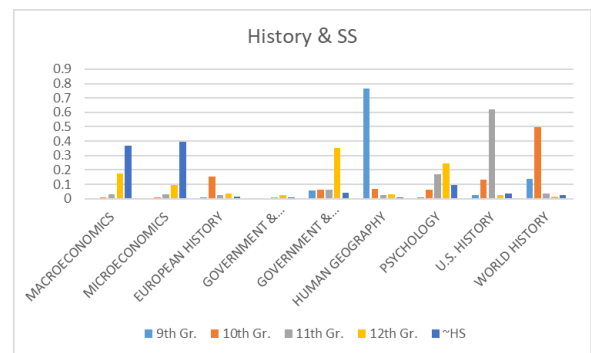


Fig. 6: Distribution of History & Subjects

**AP English:** Figure 7 shows the popularity of AP English subjects. The two subjects in this group show very clear trends in popularity. Freshmen, sophomores, and juniors all prefer English Language and Composition over English Literature and Composition. Moreover, the preference of the former increases through the 11<sup>th</sup> grade, whereas the popularity of the latter drops. The balance shifts, however, among high school seniors where English Literature and Composition assumes a significantly greater percentage compared to Language and Composition. Finally, these two subjects are favored equally in the pre- high school group, again making the distribution of the subjects in this group very different compared to other grade levels in high school.

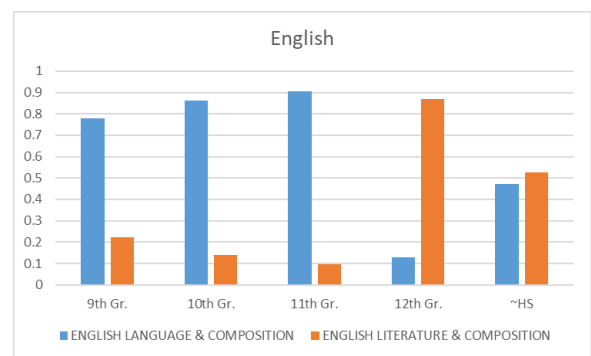


Fig. 7: Distribution of English Subjects

## RELATED RESEARCH

In this section, I survey and compare related research. A large body of work has examined how participation in the AP program influences performance prior to and in college. For example, Warne and Odasso [18] found a positive impact of passing the AP exam on the college admissions test scores. Ackerman et. al. [19] examine whether AP exam performance can be predictive of academic success in college, accounting for gender differences in the selection of STEM vs. non-STEM majors and of STEM persistence. Mattern et. al. study the positive association between students' performance on AP English, Biology, Calculus and U.S. History on the success in college [20]. Mattern et. al. [21] investigate the role of AP curriculum in the choice of college majors and in increasing the number of STEM graduates and workforce. Given the observed benefits of AP classes and exams, studies have also examined how to incentivize students to participate in the AP curriculum. Jeong found that exam fee preemption is the most prevalent incentive to increase the likelihood that disadvantaged students will take the AP exam [22].

The work reported in this paper differs from the related works reported above in many respects. Most of the prior investigations use a small subset or a cohort of data, say from a particular state, a particular college, or a subset of the AP subjects. Moreover, their emphasis is on investigating the predictive power of AP on college majors and college success. By contrast, we use the entire gamut of data published by the College Board, in a single administration of the AP exam. Furthermore, our focus is on identifying the preferences of the students for different AP subjects during the middle school and high school grades. This understanding can shed light into the reasons why students take different AP subjects, and provide opportunities to cultivate genuine interest in these subjects as opposed to just taking the tests for strategic advantage in the college admissions process and beyond.

## CONCLUSIONS & FUTURE RESEARCH

In this paper, I analyzed the grade-wise preferences for AP subjects divided into six AP subject areas. I considered four years of high school grades, and students younger than high school. I summarize my results below:

- **AP Subject Areas** – Social Studies is the most popular subject area through all four years. The percentage for Social Studies is lopsided among 9<sup>th</sup> and 10<sup>th</sup> graders, but reaches a balance in 11<sup>th</sup> and 12<sup>th</sup> grades. Arts and World Languages account for a maximum of 5%. Among younger students, Math subjects are the most common.
- **AP Arts:** Music Theory, Art History, and Studio Art 2D Design account for about 90-95% tests. Studio Art 3D Design is not favored by high school students, but it accounts for a respectable 10% among the younger group of students.

- **AP Science:** Biology is the most popular AP subject in high school, students are balanced between Physics 1 and Chemistry, Environmental Science stays around 20%, and interest in Physics C: Mechanics rises through the high school and peaks among seniors. Students may find it confusing to sort through the four Physics offerings. Younger students seem to favor Physics: Mechanics and Chemistry over Biology.
- **AP Math:** Computer Science is the most popular among 9<sup>th</sup> graders, Statistics and Computer Science are equally popular among 10<sup>th</sup> graders. Juniors and seniors favor Calculus courses, with AB over BC.
- **AP World Languages & Culture:** Spanish Language is overwhelmingly popular through high school. French comes in at a distant second in the 12<sup>th</sup> grade. Younger students seem to favor Chinese, perhaps because it is native to their families.
- **AP History & Social Studies:** This subject area is most difficult to find trends, swings are dramatic and each grade has its favorite. Human Geography in the 9<sup>th</sup> grade, U.S. History in the 10<sup>th</sup> and 11<sup>th</sup> grades, U.S. Government and Politics in the 12<sup>th</sup> grade, and Economics in the pre- high school, younger group.

In summary, I found that younger students show different preferences compared to high school students. The respectable percentages earned by Physics C: Mechanics, Studio Art 3D Design, Chemistry, Calculus, and Economics, suggest that younger students do not shy away from difficult subjects, and appear to choose their AP classes based on their passion and interests rather than from the point of view of positioning for college. On the other hand, as students proceed through high school, their choices of AP subjects may be more driven by gaining strategic advantage in during college admissions. Therefore, the popularity of the Science subjects grows and Social Sciences subjects drops through high school.

Given the importance of computing to all disciplines, schools should make a concerted effort to increase interest in computer science, by empowering more students with the necessary computing and programming background. The popularity of Biology suggests an inclination towards careers in the life sciences rather than engineering; targeted efforts to enhance interest in physical sciences may be desirable. Moreover, with the urgent threat of climate change, it would be desirable to encourage students to choose Environmental Science.

My future research consists of understanding whether significant differences exist in AP performance among the various demographic groups.

## AUTHOR INFORMATION

**Adway S. Wadekar**, is a freshman at Westborough High School, Westborough, MA. His interests lie in harnessing the power of data science to drive sound policy decisions. He is a contributor to the Kaggle data science community,

and has won regional, state, and national level awards at science fairs for data science related projects.

#### REFERENCES

- [1] <https://apstudent.collegeboard.org/home>
- [2] <https://research.collegeboard.org/programs/ap/data/archived/ap-2016>.
- [3] <https://www.kaggle.com/collegeboard/ap-scores/kernels?sortBy=hotness&group=everyone&pageSize=20&language=all&outputType=Data&datasetId=769>.
- [4] <https://apstudent.collegeboard.org/apcourse>.
- [5] <https://apstudent.collegeboard.org/apcourse/ap-calculus-ab>
- [6] <https://apstudent.collegeboard.org/apcourse/ap-calculus-bc>
- [7] <https://apstudent.collegeboard.org/apcourse/ap-physics-1>
- [8] <https://apstudent.collegeboard.org/apcourse/ap-physics-2>
- [9] <https://apstudent.collegeboard.org/apcourse/ap-physics-c-mechanics>
- [10] <https://apstudent.collegeboard.org/apcourse/ap-physics-c-electricity-and-magnetism>.
- [11] <https://apstudent.collegeboard.org/apcourse/ap-spanish-language>
- [12] <https://apstudent.collegeboard.org/apcourse/ap-spanish-literature-and-culture>.
- [13] <https://apstudent.collegeboard.org/apcourse/ap-spanish-language>
- [14] <https://apstudent.collegeboard.org/apcourse/ap-spanish-literature-and-culture>
- [15] <https://apstudent.collegeboard.org/apcourse/ap-english-language-and-composition>
- [16] <https://apstudent.collegeboard.org/apcourse/ap-english-literature-and-composition>
- [17] H. Edwards, "Average AP Scores for Every AP Exam," <https://blog.prepscholar.com/average-ap-scores-for-every-ap-exam>
- [18] R. T. Warne, R. Larson and A. Odasso, "The impact of participation in Advanced Placement program on students' college admissions test scores," *Journal of Educational Research*, vol. 108, issue 5, 2015.
- [19] P. L. Ackerman, R. Kanfer, and C. Calderwood, "High school advanced placement and student performance in college: STEM majors, non-STEM majors, and gender differences," *Teachers College Record*, 115(10), 1-43, 2013.
- [20] K. D. Mattern, E. J. Shaw and X. Xiong, "The relationship between AP exam performance and college outcomes," *College Board Research Report No. 2009-4*, The College Board, NY 2009.
- [21] K. D. Mattern, E. J. Shaw and M. Ewing, "Is AP exam participation and performance related to the choice of college major?," *College Board Research Report No. 2011-6*, The College Board, NY 2011.
- [22] D. W. Jeong, "Student participation and performance on Advanced Placement Exams: Do state sponsored incentives make a difference?" *Journal of Education Evaluation and Policy Analysis*, December 2009.