

# Influence of socioeconomic status on academic performance in virtual classroom settings

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## SUMMARY

As the children of immigrant parents, we understand the significant extent to which education is a tool for becoming contributing global citizens. During the COVID-19 pandemic, witnessing first-hand how socioeconomic inequalities were affecting education, we were determined to make a difference. We conducted an online survey to evaluate the impact of household socioeconomic status (SES) on student participation and performance in distance learning at the height of the COVID-19 in communities along the Monterey Bay Peninsula. SES is defined as the combined measure of gross income, educational attainment, and occupation. We hypothesized that students from low-socioeconomic households lacking resources and safe and supportive learning atmospheres would seldom participate during distance learning; therefore, earn lower grade point averages (GPAs) than students from higher SES households. We surveyed students from neighboring high schools whose student bodies are separated by a vast wealth gap, and utilized a novel scoring system to quantify the responses specifically for SES and direct participation factors (e.g., unmuting to participate in a class discussion and typing answers into the chat). The results suggested that high SES for Carmel High School and low SES for Monterey High School had a substantial impact on student achievement during distance learning. The average participation score for Carmel students was statistically significantly greater than Monterey students. Furthermore, students from the upper SES range attained higher weighted GPAs. This work ultimately reveals the inequality present in our current education system and the negative implications for low SES students in the online learning environment.

## INTRODUCTION

The COVID-19 pandemic brought on a multitude of educational barriers for students in America. During the 2019-2020 school year, all 50 states shut down their public schools at some point during the year, affecting nearly 50.8 million students (1). Merely 50% of districts nationwide provided elementary instruction for more than four hours per day during remote learning, while 85% of them decreased instructional time to less than four hours; during pre-pandemic times, the national average for instructional hours per day was five (2). Exacerbating the education crisis, nearly 17% of surveyed

school districts reported that their instruction in Spring 2020 was not designed to teach new skills and understanding, but to review concepts that had already been taught in the previous years (2).

Throughout the 2020-2021 academic year, as orders concerning school re-opening were made by state health officials, schools, school boards, and districts, schools across the US were in various stages of instruction, including fully online, fully in-person, and hybrid learning (3). There were overall improvements; 34% of schools offered over five hours of live instruction for eighth graders during virtual learning, and 88% of schools nationwide offered some form of in-person learning (3). Still, in states such as California, which was the epicenter of COVID-19 in the United States at one point, the majority of 6.1 million students remained in distance learning until Governor Gavin Newsom added \$2 billion in incentives for all elementary grades and at least one grade in middle school or high school to open by April 1st, 2021 (4,5). However, this initiative was not a breakthrough in learning for students as many schools could not afford to expedite the critical steps of reopening and the lingering challenges of high COVID-19 transmission rates, especially among low-income communities (5). Furthermore, for Black, Latinx, and Asian students across the U.S., there was a substantially lower rate of enrollment in full-time in-person instruction through the Spring 2021 (2).

Several prior studies have discovered connections between SES and learning at a variety of ages in children. Prior research has revealed that children at 24 months of age from low SES households and communities tend to display learning-related behavior problems including lack of task persistence, inattention, disinterest, frustration, and non-cooperation, thus resulting in poor academic performance (6). Morgan, Paul L. et al reported that the mother's level of education was strongly correlated to the child's completion of fine motor and cognitive skills for the same age group (6). Similarly among older adolescents, a positive association between neighborhood affluence or neighborhood high SES and youths' chances of completing secondary school, attending college, and years of schooling completed was found. This association can, to some extent, be attributed to higher rates of delinquency and crime as well as internalizing behaviors among 13- and 16- year old males residing in low SES or underclass neighborhoods (7). Further, research showed that low SES directly correlates with high school dropout rates, a standard measure of student success (8). According to NCES, students from low-income families have a drop out rate of 10%; students from middle income families have a dropout rate of 5.2%; 1.6% of students from high-income families dropout. As expected, high SES students are

provided with more opportunities to interact with adults who have pursued higher education, therefore they have greater motivation to graduate and gain the skills necessary to confidently navigate the career world (9). Such psychological factors (i.e., life experiences, social networks, and other aspects of daily life) and SES are strong determinants of students' academic motivation and performance (9).

We conducted an online survey of students at Monterey and Carmel High Schools in Monterey County, California to investigate how a low or high household SES impacts a student's learning at home. While 52% of Monterey High School students are economically deprived, merely 17% of Carmel High School students are financially disadvantaged (10, 11). Consequently, Monterey High School students score remarkably lower than Carmel High School students, as much as 42% lower, on State English and Mathematics tests each year (11). Due to the spread of COVID-19 and statewide school closures, we hypothesized that educational inequalities have only exacerbated between students from low and high SES households during the time of distance learning with more extensive parental or guardian influence. Hence, high SES students attain higher GPAs compared to low SES students. We investigated the critical factors influenced by household SES that affect students' ability to participate and ultimately academically succeed in distance learning.

We examined the importance of both direct and indirect factors on learning including access to web cameras, safe and positive learning environments, and necessary learning materials like functional computing devices, school supplies, and a reliable network connection, all of which are accessible by both low- and high- SES students under normal learning conditions at in-person school. Household SES was compared to students' self-reported participation in class (e.g., unmuting to contribute to group discussions) and students' self-reported weighted GPAs from the first semesters of 2019 and 2020.

Results revealed higher correlation between SES and active participation for upper SES students in relation to lower SES students. Likewise, high SES students performed better academically during distance learning. However, there was no significant difference found between SES and a *safe* and *supportive* learning environment, which deviates from the hypothesis and suggests how stereotypical beliefs may play a role as well as how educational inequity between high and low SES students may not have exacerbated during at-home learning. Therefore, the results section is followed by a detailed discussion of the various limitations/caveats. Nonetheless, the findings of this research uncovered the flaws within the current educational system and may better guide school authorities in assisting students, specifically during COVID-19 and distance learning.

## RESULTS

To briefly introduce the methods, the SES score is on a scale of 1 to 8 where 1 is the lowest possible score and 8 is the highest. The score is the mean of income, education, and occupation (the highest in demand in Monterey County are listed as possible responses (15)), which are also on a scale of 1 to 8 as shown by **Tables 1, 2, and 3**. Similarly, the score for direct participation is on a scale of 0 to 5 and is based on the engagement level on online learning platforms, usage of video cameras, and internet connection. For indirect participation, students simply provided a yes or no response

regarding the safeness and supportiveness of their home learning environment.

We analyzed the survey data of 194 participants in total from Monterey and Carmel High School. Carmel students had a statistically significant higher average SES score compared to Monterey students ( $5.9 \pm 1$  vs.  $4.1 \pm 2$ , unpaired t-test,  $p < 0.0001$ ). The values are described as mean  $\pm$  standard deviation. The higher SES resulted in a higher average participation score for Carmel students relative to Monterey students ( $3.5 \pm 1$  vs.  $2.7 \pm 1$ , paired t-test,  $p < 0.001$ ). The average for Carmel students was 0.8 greater in value than Monterey's average (the number's range was 0-5), meaning that a greater number of students unmuted to speak, typed answers into the chat, and interacted on online learning platforms, which students had equal accessibility to. The data was further supported by a higher concentration of

Income	Score	Participant Number
\$0-23000 and \$23000-32000	1	20/194
\$32000-40000 and \$40000-48000	2	15/194
\$48000-57000 and \$57000-65000	3	24/194
\$65000-73000 and \$73000-82000	4	35/194
\$82000-100000	5	25/194
\$100000-150000	6	35/194
\$150000-200000	7	17/194
\$200000+	8	23/194

**Table 1: Assigned scores for each SES range based on gross household income in 2020.** All values are in U.S. dollars.

Occupation	Score	Participant Number
Farming, Fishing, and Forestry	1	4/194
Food Preparation and Serving related	2	27/194
Material Moving and Sales related	3	27/194
Educational Instruction, Library and Office, and Administrative Support	4	41/194
Management	5	33/194
Computer, Engineering, and Science	6	10/194
Architecture and Engineering	7	7/194
Healthcare Practitioners & Technical	8	44/194

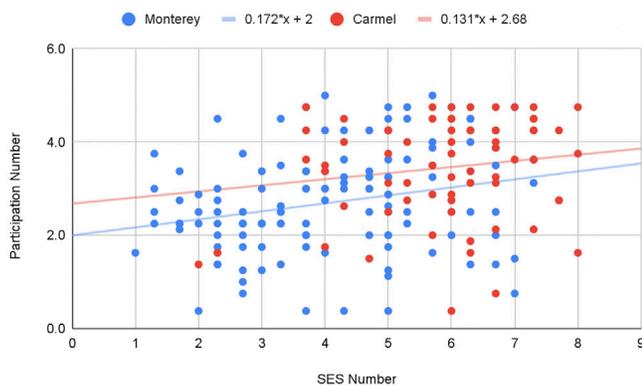
**Table 2: Assigned scores for survey responses indicating parent or guardian profession.** The eight industries listed are the most in demand in Monterey County.

Education	Score	Participant Number
Never completed high school	1	9/194
High school or equivalent	2	28/194
Some college coursework completed	3	19/194
Technical or occupational certificate and Associate degree	4	7/194
Bachelor's degree	5	51/194
Master's degree	6	57/194
Doctorate	7	15/194
Professional (e.g., MD and JD)	8	8/194

**Table 3:** This table displays the scores for the parents' education level.

points along with the upper values of the x- and y-axis for Carmel students, which show the estimated SES number and the participation score, respectively (Figure 1). Regarding SES and technology engagement, Monterey had a stronger Pearson correlation coefficient than Carmel (0.253 vs 0.158) (Figure 1).

We found that 72.8% of students from the 1 to 4 SES range and 65.9% of students from the 5 to 8 SES range indicated that they have a *safe* learning environment. 63.1% of students from the upper SES range and 55.0% of students from the lower SES range reported that they have perceptions of *support*. Students with lower range SES numbers, who did not feel physically comfortable, emotionally stable, and/or have rapport with their parents, were less likely to participate



**Figure 1: SES Versus Active Participation.** Bar graph showing the correlation between Monterey and Carmel High School students' SES scores 1-8 and participation number, based on a novel scoring method. This is higher for Carmel High students ( $p < 0.0001$ ). Monterey has a stronger Pearson correlation coefficient than Carmel ( $r = 0.253$  versus  $r = 0.158$ ). Data collected through an online survey of family's household size, parent's income level, qualification for free and reduced status, occupation, and education level for SES and activity level on learning platforms and usage of video camera for participation.

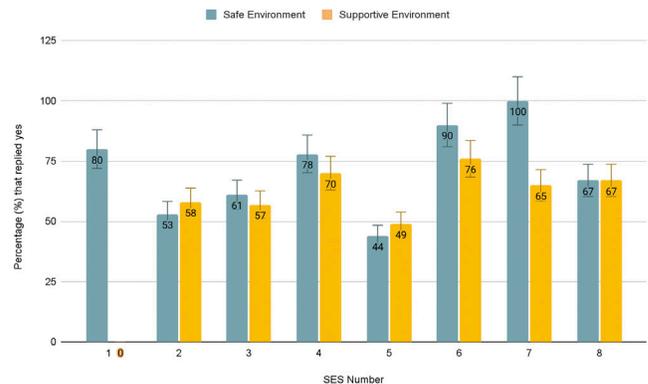
in class depicted by Figure 2. Meanwhile, for students with upper range SES numbers, they studied in safe and supportive environments where academics was prioritized, parents were involved, and distractions were minimized; they hardly experienced learning disruptions caused by internet connection issues, resulting in high participation scores. In addition, high SES students noted that they had separate rooms in the house designated as a study, allowing them to achieve a higher level of participation in class.

To compare whether there is a significant difference between the two correlations, an ANOVA analysis was used to calculate the larger sample variance, which was 18820.46. For the supportive learning environment, the smaller sample variance was 18817.69. The calculated F value is approximately 1.00, so regardless of the significance level, the variance is equal among high and low SES students which deviates from the hypothesis made earlier.

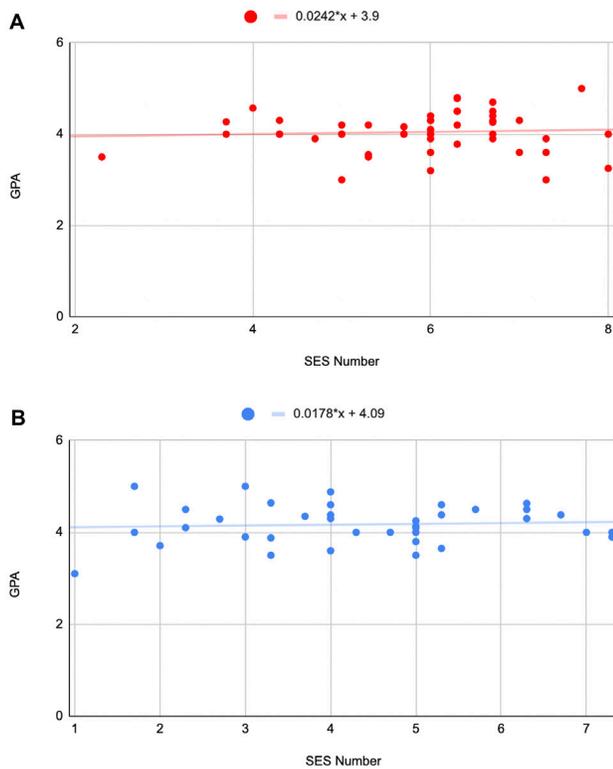
For measures of academic performance, before grouping the data from both schools together for GPA, the trend for each school was examined separately, which were identical as shown by Figure 3. Then, we found that students from the lower SES range reported a greater average of failed classes compared to students from the upper SES range ( $0.32 \pm 0.8$  vs.  $0.12 \pm 0.5$ , paired t-test,  $p = 0.05$ ). Due to an inadequate number of failed classes for each SES category, we binned the data only as "low" and "high." Therefore, a paired t-test was utilized instead of an ANOVA analysis. When we compared the 2020 weighted GPAs, students from the lower SES range scored a lower average compared to students from the upper SES range ( $3.78 \pm 0.72$  vs  $4.09 \pm 0.60$ ,  $p = 0.002$ ).

## DISCUSSION

The research aim is: the influence of household SES on a student's ability to participate and achieve academics during COVID-19. We conducted a survey of Monterey and Carmel High School students regarding household SES status, direct



**Figure 2: SES Versus Home Learning Environment.** Double bar graph comparing the percentages of Monterey and Carmel High students with SES scores 1-8 that have access to safe and supportive learning environments. Data collected from participants checking boxes with characteristics of safe and supportive learning environments, for example yes/no, my parents are engaged in my learning. Error bars present standard deviation. High SES students have a greater mean percentage compared to low SES students by 7.25% for a safe environment and likewise, 18% for a supportive environment. An ANOVA analysis, however, showed equal variance between low and high SES students ( $F = 1$ ).



**Figure 3: SES Versus Academic Achievement.** Figures showing the correlation between GPA and SES for Monterey (A) and Carmel (B) High school students. Data collected through participants self-reporting their number of failed classes in a single semester during virtual learning as well as their weighted GPAs (5.0 scale). High SES students (A) show stronger correlation for numbers of classes compared to low SES students (B) ( $p = 0.05$ ). A paired t-test revealed significant results for weighted GPAs ( $p = 0.002$ ).

and indirect participation, and academic achievement. All of the responses provided were self-reported. The overall result provides evidence for the blatantly unfair disadvantages that low SES students face, compared to high SES students, amid online learning.

As we hypothesized, compared to Monterey households' SES scores, Carmel households' scores were significantly higher (Figure 1). Further, the mean and standard deviation suggests that there is a strong correlation between household SES scores and student participation ( $p < 0.001$ ). High SES students with educated parents are afforded the luxury of time, a high quality early education, and experienced instructors to focus on their academic goals. However, according to the ANOVA analysis ( $F = 1$ ), there was no significant difference found between SES and safe and supportive learning environments, suggesting that correlation between poverty and parents can be based on stereotypical beliefs. Nearly every student had functional laptops and school resources available to them, so socioeconomic level played no significant impact on these measures. Hence, there may exist a stronger correlation between SES and academic performance in a school system where students lack access to computers.

Students with high SES numbers and participation scores also achieved higher academic performance. However, it is

critical to note that an A at Monterey High School might not be equivalent to an A at Carmel High School due to problems such as grade inflation and deflation. Therefore, depending on the school and student, GPA, the most readily available assessment, may be an outdated measure for academic performance. Taking factors such as graduation rates, attendance rates, and discipline referrals into consideration could greatly increase the validity of the experiment.

Furthermore, our study relied on a cross-sectional correlational design, therefore there is a possibility of third variables distorting conclusions. For example, the positive relationship between SES and GPA can be attributed to variables like students' difficulty with juggling school, a part-time job, and responsibilities at home, dealing with mental challenges (i.e. high anxiety, low focus, and lack of intrinsic motivation), or each respective school's modifications to grading during COVID-19. There was limited information regarding the demographics of the survey participants, such as gender and race and ethnicity, which could contribute to the trends that were shown and not shown. Moreover, the number of responses from Monterey High school was double of Carmel High school, so the data may not fully reflect the circumstances of their entire student body or individuals of higher socioeconomic level. Monterey High School's student body shares a similar population to Carmel High School's, which is approximately 1,400. To minimize these limitations, future studies involving direct monitoring of participation time on online learning platforms and the level of physical and emotional support at home or collection of student records directly from school administrators could be completed. Another study could examine SES and school achievement over a prolonged period of time (pre- and post- pandemic). It is worth mentioning that there may have been responder bias because students felt insecure or had no knowledge of their low or high socioeconomic status. In addition, the responses were based on individual's perceptions of their learning environment (i.e., wifi that works for one may not work for another). Methods to reduce responder bias would be to emphasize throughout the survey that the responses will remain anonymous and ensure that none of the answer options are leading, keeping the questions clear and concise. The addition of details in the answer choices provided could set a clearer standard of what works and what doesn't work for individuals.

In conclusion, our research has shown that students of lower SES (low family income, parents acquired lower levels of education, and parents had "blue-collar" jobs) are at-risk to suffer the consequences of low participation in virtual learning, which supports prior studies designed to evaluate the effect of SES on a student's learning-related behavior problems (6). These students may have lacked a *quality* early education, which has a profound impact on a child's literacy, numeracy, cognitive development, social emotional-development, and motor skills (6), leading to the SES differences in GPAs revealed in this study. Another cause may be the cultural bias in testing systems that puts students of color, students of lower SES, and students who are not fluent in the English language at an obvious disadvantage and have higher predictability for those students to score significantly lower (12). All in all, closer attention and a stronger system of support, such as additional tutoring, counseling services, or instruction for social-emotional learning strategies, must be provided for

vulnerable students. It is extremely crucial as many schools adapt to the hybrid or fully in-person learning model that the education of students with additional family responsibilities, jobs, and transportation issues is not compromised. Opportunities for future research include how SES can impact a student's ability to make academic progress after months of falling behind during remote school. In addition, external factors that might influence a student's performance such as intrinsic motivation, nutrition, and gender could be assessed.

## MATERIALS AND METHODS

### Data Collection

Quantitative and qualitative data was collected through an online survey consisting of questions regarding background information, online learning during COVID-19, and student performance (Table 4). The aim was to conduct the survey with the student body at Monterey High School and Carmel High School from January 12th to February 5th, 2021. A

student was defined as an individual who is enrolled in Monterey or Carmel High School as a 9th, 10th, 11th, or 12th grader for the 2020-2021 school year. Participants were given unlimited time to complete the survey once on a Google Form anonymously.

A total of 194 high school students, 69 students from Carmel High School and 125 students from Monterey High School, provided enough information for proper analysis of data. At Monterey High School, Hispanics make up 49.7% of the student body, Whites 29.7%, and Asians 12.2% of the population (10). At Carmel High School, Whites make up 62%, Hispanics 18.4%, and Asians 5.2% of the population. The study was not limited to any gender (11).

Before analysis, each survey was carefully checked for completeness. Surveys that were entirely empty or with incomplete responses regarding income and participation were not considered. Either the number of failed classes or a comparison of 2019 and 2020 GPAs must have been

Background Information	Online Learning During COVID-19	Student Performance
How many people live in your household (including yourself)?	Throughout the week, do you frequently participate in your classes? EXAMPLES: typing answers into the chat, unmuting to speak, answering interactive questions (ex. Pear Deck, Kahoot, and Desmos). NOTE: if you only log onto class, that does NOT count.	Do you believe the COVID-19 pandemic has had a negative impact on your overall learning?
What was your household's gross income for the 2020 year? Select a range that contains the CLOSEST value.	Throughout the week, do you frequently turn on your video/camera in your classes?	What are the NEGATIVE consequences of virtual learning? Check ALL that apply.
Do you qualify for free and reduced lunch at school?	Do you typically keep your video/camera on for a whole class period?	Is there anything else you'd like to share about the negative consequences of virtual learning? (OPTIONAL)
What are your parents' occupations? Check ALL that apply.	Is your home learning environment safe? Check ALL that apply.	What are the POSITIVE consequences of virtual learning? Check ALL that apply.
Indicate your PARENT/GUARDIAN ONE's highest level of education attained.	Is your home learning environment supportive? Check ALL that apply.	Is there anything else you'd like to share about the positive consequences of virtual learning? (OPTIONAL)
Indicate your PARENT/GUARDIAN TWO's highest level of education attained, if applicable.	Is there anything else you'd like to share about your home learning environment? (OPTIONAL)	What grades have you received in your classes during distance learning? Check ALL that apply.
	Do you have access to a fully-functional laptop, chromebook, tablet, or any other computing device?	Have you failed (received Fs) in any courses in these subject areas? Check ALL that apply.
	Do you experience disruptions in your Zoom and/or Google Meet classes because of your internet? EXAMPLES: having to rejoin the meeting, the meeting freezing, computer audio cutting out.	What was your estimated WEIGHTED GPA for the first semester of 2019?
	Do you have adequate access to essential school supplies? EXAMPLES: notebooks, pens, pencils, art supplies (if you take art)	What was your estimated WEIGHTED GPA for the first semester of 2020?

Table 4: This table displays the exact questions asked in the survey.

indicated for the data to remain valuable.

### SES Assessment

The first set of questions focused on assessing the participant household SES. First, they were asked how many people reside in their household (including themselves). Then, participants were asked about their household gross income range for the 2020 year (Table 1). Low to middle-class ranges of income in Monterey County were listed (e.g., \$65,000-\$73,000), in which the majority of Monterey High School families fall (10). The highest income range was indicated by \$200,000+, which is near the top 5% of median household income in Monterey (13). This is adequate information to determine that families above that threshold are financially capable of investing in education of some form and no further binning is required. A subsequent question about whether the students qualify for free and reduced lunch was asked as it provides a rough estimate of their income if they chose not to answer the previous question. Next, participants indicated their parent or guardians' occupations (Table 2). A list of the most common jobs held by the residents of Monterey County was provided; the jobs were ranked based on level of income. The students also indicated their parents' highest level of education attained with the lowest scoring being "never completed high school" and the highest scoring being "professional" (Table 3).

For SES, a score from one (lowest) to eight (highest) was provided for each of three categories: family income/free and reduced lunch, which children in households with incomes below 130% of the poverty level are eligible for (14), highest level of education attained by parents, and parental occupations. We computed a final SES score for each participant based on the average of the SES score for each of these three categories (Tables 1-3). If a student indicated a parent career related to farming, fishing, and forestry, he or she received a score of 1, because the median income for that industry is lowest (15). In contrast, if a student reported a parent career related to the health practitioners and management, he or she received a score of 8. If a job did not fall within the industry choices on the survey (e.g., pilot), the score closest in median income to an available industry was assigned. An important caveat about the career variable is that all jobs in one industry cannot be accounted for, for example in the category "Education Instruction & Library", there is a large variance in salary between a superintendent and a first-year teacher. However, we aimed to achieve high accuracy by taking both education and income levels into account when calculating the SES scores.

### Direct Participation

The next set of questions focused on assessing participant experiences with virtual school and academic success. Participants were asked how many days of the week they actively participate in class (i.e., unmuting to speak and answering questions on interactive platforms), turn on their video cameras, and experience internet disruptions.

A similar scoring system was utilized to quantify the data regarding student participation in virtual school. Each student was given a rating of 0 through 6, 0 for "never participating in class" and 5 for "participating [in] every class every day." The same system was used for days/weeks of camera usage. For the length of camera usage, a student was rated 0 for

"never having the camera on" and 5 for having it on "every class every minute." For internet disruptions, a student was rated 0 for experiencing them "every class every day" and 5 for having a "internet [that] works just fine." An average of the categories was used to represent the student participation number.

### Indirect Participation

Students were asked if they feel *physically* and *emotionally* safe at home, which is most likely influenced by their level of rapport with parents. Moreover, they were asked about academic work being prioritized in the household (i.e., if the students perceive that their parents are invested in their education and the availability of a space to work on assignments with distractions minimized).

To quantify indirect participation factors, students provided yes (Y) or no (N) answers to questions about their learning environment. A learning environment was deemed safe if the student reported feeling physically comfortable and emotionally stable and developed a strong relationship with their parents or legal guardians. A learning environment was considered supportive if academic work was prioritized in the family, distractions during virtual school were minimized, and there was a dedicated room for study space. The percentage of "Y"s from both the lower and upper SES range for questions regarding safe and supportive learning environments was calculated.

### Academic Performance

For academic performance, participants were provided checkboxes with a list of positive and negative consequences of virtual learning (e.g., the cost-effectiveness of virtual learning compared to in-person school due to reduced transportation (positive), and feelings of loss of self-motivation (negative)). Then, they were asked to indicate their most recent letter grades in all core subjects along with their first semester weighted GPAs from 2019 and 2020.

### Statistical Analysis

An unpaired *t*-test was used to assess the statistical significance between the distributions of SES between the two schools ( $\alpha = 0.05$ ). A paired *t*-test was used to determine the difference in correlation among the variables SES, technology engagement, perceptions of safety, and GPA. The Pearson correlation coefficient (R) was calculated to interpret the correlation between SES and the level of active participation (16). An ANOVA analysis was performed to compare the effect of multiple SES values on indirect participation and academic performance at once (17). The F value was derived from dividing the larger sample variance by the smaller sample variance and comparing it to the F statistic value in order to accept or reject the null hypothesis (Table 5). The statistical tests were run on Google Sheets and Microsoft Excel when needed.

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Source of Variation	Sums of Squares (SS)	Degrees of Freedom (df)	Mean Squares (MS)	F
Between Treatments	$SSB = \sum_{j=1}^k n_j (\bar{X}_j - \bar{X})^2$	n-k	$MSB = \frac{SSB}{n-k}$	$F = \frac{MSB}{MSE}$
Error	$SSE = \sum_{j=1}^k \sum_{i=1}^{n_j} (X_{ij} - \bar{X}_j)^2$	k-1	$MSE = \frac{SSE}{k-1}$	
Total	$SST = \sum_{j=1}^k \sum_{i=1}^{n_j} (X_{ij} - \bar{X})^2$	n-1	$\bar{X}$	

**Table 5. Analysis of Variance (ANOVA) table.** Abbreviations for the respective terms SSB, SSE, SST, MSB, and MSE: Sum of Square Between, Sum of Square Error, Sum of Square Total, Mean Square Between, and Mean Square Error.

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