EXTENSION

# Do Home Computers/Internet Access Affect Student Performance?

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## Introduction

Technology continues to rapidly advance in our society, with more than 70% of U.S. households having an internet connection at home (Pew, 2019). However, access to and use of this technology has been uneven across geographies and demographics – a problem known as the "digital divide." For example, only 62% of households making less than $20,000 have an internet connection, compared to more than 95% of households making more than $75,000. Access to the internet has been shown to be important for a variety of issues, including healthcare, business and entrepreneurship opportunities, income and employment levels, and social connectivity.

Technological advancements also have been working their way into education, where classrooms have become much more computer intensive. The "homework gap" – where some school-age children lack home access to computers and the internet – has become a widely recognized issue (Auxier and Anderson, 2020). An open question is to what extent home technology access matters: Do school districts with higher levels of computers or internet access at home perform better on standardized tests, if all other factors are equal? Does the impact vary by grade level? As the COVID-19 pandemic evolves, what can we learn from this to assist with digital learning? This research utilizes Census and Oklahoma school profile data to answer these questions.

## What Else Affects Student Performance?

It is important to establish some of the non-computer-based factors that previous studies have identified as having a significant impact on student academic achievement. These factors include poverty levels, school attendance, race, local funding and parental involvement. Some research also has examined whether at-home internet and computer access affect test scores; these studies are briefly reviewed.

Poverty has continuously been shown to inhibit student academic performance. Studies have documented that while the "money" portion of poverty is detrimental on its own, other factors often found in impoverished households can increase poverty's damaging effects. These factors include the possibility of being in a single-parent household, substance abuse, child neglect and heightened family involvement in the criminal justice system (Petrilli, 2016).

Studies also have shown a correlation between school absences and standardized test scores. One study of Ohio schools looked at fourth, sixth, ninth and 12th grades and found a statistically significant negative relationship between the number of absences and student achievement. The study demonstrated that students with more absences from school were more likely to score lower on state tests (Roby, 2004).

A persistent gap in test scores between racial and ethnic groups also has been established. One study, using data on more than 40 million U.S. students during 2009-2013, found the average black student's score was lower than those of Hispanic students, and that both black and Hispanic students scored lower than their white counterparts. This performance gap increased as grade level rose from third to eighth grade (Reardon, 2016).

Research shows that local funding matters for school performance (Jackson, 2018). In particular, a study showed that an spending increase of $1,000 in per pupil for 10 years would increase student performance by about 0.2 standard deviations (Lafortune et al. 2018).

Parental involvement in a child's education has been shown to dramatically affect academic achievement. Students with parents with a positive attitude towards their child's academic pursuits score higher on standardized tests and have better classroom performance/cognitive competence than their classmates with little or no parental involvement or support (Topor, 2010).

It is widely recognized other factors exist which likely affect student scores, but are unable to be accounted for in most studies. Some of these include the students' personal ambitions, family dynamic, classroom atmosphere, quality of classroom content, class subject focus and teacher absence rate (Trautwein, 2009; Jacobs, 2007). These factors are difficult to measure and are not included in this analysis.

In terms of technology, some states and school districts have gone to varying and costly measures to assess whether improved computer or internet access means better test scores. In some instances, investments have been made to provide take-home computers for every student in a specific grade. While providing students with a computer did increase the amount of time the average student spent online, it was not

shown to produce an increase (or decrease) in test scores. This is explained in part by the use of home computers by students for non-academic purposes (Bulman and Fairlie, 2016).

## Data and Preliminary Comparisons

The data for this current study comes from the 2018 Oklahoma School District Profiles provided by the Oklahoma Educational Indicators Program (OEIP). Profile reports are made available at the school district level (537 districts included in 2018). These reports include socioeconomic characteristics, motivation/parental support averages, classroom/administrative characteristics and educational outcomes for each district. Specifically, the percentage of students scoring above proficient in the state-mandated math and English Language Arts (ELA) tests in grades three through eight and 11 were reported for all districts. These were merged with district-level data on household computer and internet access from the 2014-2018 American Community Survey (ACS) compiled by the U.S. Census Bureau. In particular, two distinct measures of technology were gathered: the percentage of households with no computer at home; and the percentage with a wired internet connection.

Table 1 provides a preliminary look at school districts ranked as "low" or "high" based on their performance on these tests. High-ranking schools are defined as those most frequently scoring in the upper quartile (75th percentile and above) across all grades and test types, while low-ranking schools consistently scored in the lowest quartile (25th percentile and below) on the same examinations. As expected, high-ranking schools possess many of the characteristics the literature has shown to be important: fewer days absent, more households with higher education and income levels, higher parental participation levels and more Caucasian students. Notably, higher-ranking schools also have measurably higher percentages of households with wired access and lower percentages with no computer at all.

To look at the potential impact of home internet and computer access on school performance, the districts were broken into quartiles based on their technology use. Figures 1 through 4 compare performance on the math and ELA tests for districts in the highest and lowest quartiles for home-wired internet access (Figures 1 and 2) and home computer access (Figures 3 and 4).

Figures 1 and 2 show student proficiency scores are higher for districts in the top quartile of access to wired internet at home when compared to those in the lowest quartile. This trend holds true across all grades analyzed, and is consistent across math and ELA performance. The average gap between the groups is around 10 percentage points in each grade for both math and ELA scores. The lack of convergence in the trend lines shows schools where students have better home internet access consistently average higher scores in the state standardized math and ELA tests, regardless of grade.

Figures 3 and 4 show a similar pattern for districts in the highest/lowest quartiles of home computer access. The gap between the groups again favors the test scores of students in the highest quartile by just over 10 percentage points in each grade for both math and ELA scores, on average.

## Regression Results

The patterns displayed in Figures 1 through 4 show districts with better access to technology at home seem to perform better across grades and subjects. However, many other factors play a role in educational outcomes, including many of the characteristics discussed in the literature review. Table 1 demonstrates these characteristics are measurably different between low- and high-ranking school districts. Does the relationship between access to technology and school performance still hold once other factors are accounted for like local poverty levels, racial characteristics and parental involvement? A technique known as regression analysis is used to get answers. Regression analysis allows isolation of the effects of each characteristic on school performance, while accounting for the fact that other variables also may be influential. In this case, the relationship between school outcomes and other factors is summarized as:

$$Y = \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \ldots + \beta_n X_n + \varepsilon$$

Here Y represents overall test performance, $X_1$ through $X_n$ represent the different variables that could impact test perfor-

**Table 1. Characteristics of low-and high-ranking Oklahoma school districts, 2018.**

| *Variable* | *Low-Ranking School* | *High-Ranking School* | *Significance of Difference* |
|---|---|---|---|
| Average Days Absent | 10.16 | 9.19 | *** |
| Bachelor's Degree and Above (Parent) | 15.05% | 19.87% | *** |
| Caucasian | 48.49% | 56.73% | *** |
| District Revenue | 30.39% | 41.58% | *** |
| Living with Married Couple | 67.36% | 71.68% | *** |
| Median Income | $43,640.71 | $52,110.20 | *** |
| No Computer | 23.47% | 20.69% | ** |
| No High School Diploma (Parent) | 15.33% | 13.26% | *** |
| Parent-Teacher Conference Attendance | 67.48% | 78.18% | *** |
| Poverty Rate | 18.68% | 14.80% | *** |
| Teacher Salaries | $44,394.26 | $45,215.94 | ** |
| Wired Access | 45.62% | 49.85% | ** |

*, ** and *** denote statistically different means at the p<0.10, 0.05 and 0.01 levels, respectively

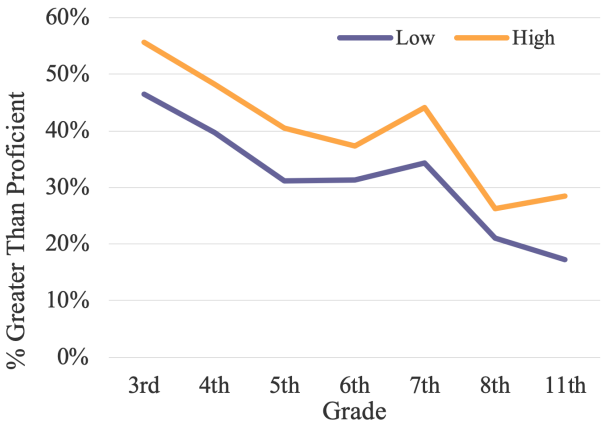


**Figure 1. Math scores for Oklahoma school districts with lowest and highest wired internet access, 2018.**

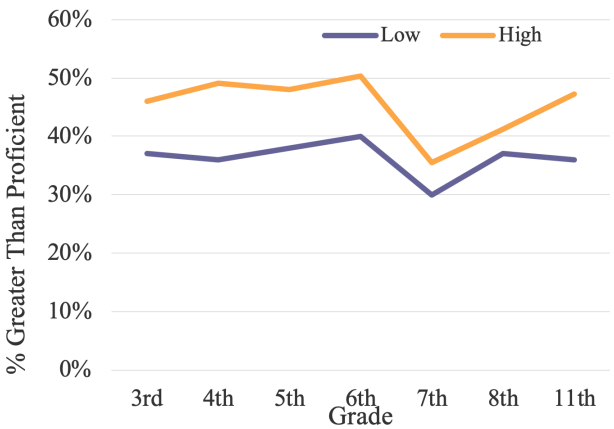


**Figure 2. ELA scores for Oklahoma school districts with lowest and highest wired internet access, 2018.**

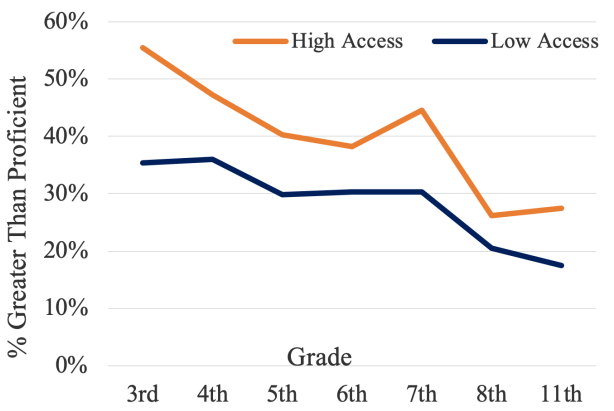


**Figure 3. Math scores for Oklahoma school districts with lowest and highest computer access, 2018.**

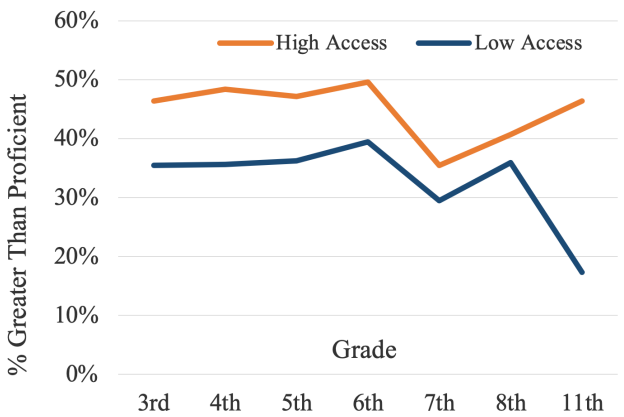


**Figure 4. ELA scores for Oklahoma school districts with lowest and highest computer access, 2018.**

mance and ε is an error term. $\beta_1$ through $\beta_n$ are the coefficients associated with each variable that tell the expected impact: a positive and significant coefficient means increasing variable X will result in higher test performance for the district.

Multiple regressions were run with a single differential variable for technology access: (1) no computer and (2) wired access. They were separated because these two variables are highly correlated with each other. The regressions are summarized in Tables 2 and 3. Each variable is listed with its corresponding coefficient and significance level represented by asterisks. Regressions were performed for third-, sixth- and 11th-grade ELA and math exam performance, with the percentage of district students scoring "proficient" as the dependent variable Y. Tables 2 and 3 also report an R^2 value which is a measure of the goodness-of-fit of the model: higher values mean that the model has more explanatory power.

Similar to prior studies, the regressions showed race, parental involvement and student attendance were all important contributors to academic success. Race-based factors showed consistently significant impacts across all grades and for both standardized testing areas. Similarly, the regression results offered strong evidence parental educational attainment is highly related to student performance (as can be seen by the large coefficients). This largely resounds earlier research on this topic.

Parental involvement and school attendance also matched earlier research and were shown to significantly affect test scores. Parental involvement (as measured by parent-teacher conference attendance) was most significant in early grade levels, which can likely be attributed to the formation of healthy home-learning environments and educational habits for younger students. School attendance (measured by the average number of days absent) demonstrates differences across grades, with significance for math at older (sixth and 11th) grades and ELA at younger (third grade). This may be explained by the increasing difficulty in math curriculum as students progress academically; alternatively, absences seem to be more important for ELA only in earlier grades – perhaps due to the need to develop foundational literacy.

One surprise was the effect carried by compensation of student educators and its significance on test score improvement. When evaluating teacher pay, the scores of 6th grade students were most significantly affected (with large coefficients); math scores for 11th grade showed some increase with higher teacher pay. However, no significance of teacher salary was shown for any 3rd grade regressions.

**Table 2. Regression results for school district proficiency scores: No computer.**

| | 3rd Grade | | | | 6th Grade | | | | 11th Grade | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Variable* | *ELA* | *Sig* | *Math* | *Sig* | *ELA* | *Sig* | *Math* | *Sig* | *ELA* | *Sig* | *Math* | *Sig* |
| No Computer | -0.146 | | 0.067 | | -0.035 | | 0.009 | | -0.299 | ** | -0.160 | |
| Avg Days Absent | -0.010 | ** | -0.006 | | -0.004 | | -0.010 | ** | -0.003 | | -0.003 | |
| Bachelors Degree and Above | 0.390 | ** | 0.467 | *** | 0.295 | ** | 0.354 | *** | 0.620 | *** | 0.550 | *** |
| Caucasian | 0.114 | * | 0.214 | *** | 0.169 | *** | 0.123 | ** | 0.156 | *** | 0.130 | *** |
| District Revenue | 0.068 | | -0.053 | | 0.012 | | -0.042 | | -0.084 | | 0.013 | |
| Living with Married Couple | -0.087 | | 0.006 | | -0.054 | | 0.109 | | -0.013 | | 0.071 | |
| (Ln) Median Income | 0.003 | | 0.09 | | 0.099 | | 0.055 | | -0.032 | | 0.016 | |
| Parent Teacher Conference Attendance | 0.174 | *** | 0.142 | ** | 0.108 | ** | 0.084 | | 0.008 | | -0.037 | |
| Poverty Rate | 0.108 | | 0.208 | | 0.088 | | 0.083 | | 0.016 | | 0.206 | |
| (Ln) Teacher Salaries | 0.220 | | 0.227 | | 0.429 | *** | 0.414 | *** | 0.152 | | 0.217 | * |
| Constant Coeff | -2.094 | | -3.180 | | -5.388 | *** | -4.865 | ** | -0.966 | | -2.450 | * |
| R^2 | 0.140 | | 0.135 | | 0.180 | | 0.147 | | 0.188 | | 0.259 | |

*, ** and *** denote statistical significance at the p<0.10, 0.05 and 0.01 levels, respectively.

**Table 3. Regression results for school district proficiency scores: Wired access.**

| | 3rd Grade | | | | 6th Grade | | | | 11th Grade | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Variable* | *ELA* | *Sig* | *Math* | *Sig* | *ELA* | *Sig* | *Math* | *Sig* | *ELA* | *Sig* | *Math* | *Sig* |
| Wired Access | 0.117 | | 0.019 | | 0.147 | * | -0.016 | | 0.176 | ** | 0.252 | *** |
| Avg Days Absent | -0.010 | ** | -0.007 | | -0.005 | | -0.010 | ** | -0.004 | | -0.006 | * |
| Bachelors Degree and Above | 0.349 | ** | 0.437 | *** | 0.208 | | 0.363 | *** | 0.573 | *** | 0.414 | *** |
| Caucasian | 0.112 | ** | 0.208 | *** | 0.161 | *** | 0.124 | ** | 0.157 | *** | 0.120 | *** |
| District Revenue | 0.068 | | -0.055 | | 0.009 | | -0.041 | | -0.086 | * | 0.014 | |
| Living with Married Couple | -0.088 | | 0.018 | | -0.037 | | 0.108 | | -0.033 | | 0.076 | |
| (Ln) Median Income | 0.006 | | 0.076 | | 0.076 | | 0.057 | | -0.008 | | -0.006 | |
| Parent Teacher Conference Attendance | 0.171 | *** | 0.142 | ** | 0.106 | ** | 0.084 | | 0.004 | | -0.045 | |
| Poverty Rate | 0.103 | | 0.215 | | 0.089 | | 0.083 | | 0.011 | | 0.193 | |
| (Ln) Teacher Salaries | 0.233 | | 0.225 | | 0.438 | *** | 0.412 | ** | 0.170 | | 0.234 | ** |
| Constant Coeff | -2.347 | | -2.988 | | -5.290 | *** | -4.856 | ** | -1.536 | | -2.499 | ** |
| R^2 | 0.141 | | 0.135 | | 0.181 | | 0.147 | | 0.189 | | 0.286 | |

*, ** and *** denote statistical significance at the p<0.10, 0.05 and 0.01 levels, respectively.

As an alternative way of viewing the results, perhaps most interesting is what factors were not shown to affect test scores. Contrary to earlier studies and often-held beliefs towards finances and academic outcomes, the results found that median household income, percentage of children living with a married couple and the poverty rate of school districts did not show any significance on scores in any grade. Surprisingly, these socioeconomic variables did not seem to exert much influence on test scores.

## Computer/Internet Variables

The computer and internet-based coefficients were only significantly related to school performance in certain instances. The percentage of households having no home computer and home-wired access were both largely insignificant in the 3rd and 6th grades, with a single exception (and only at the p<0.10 level, for wired access and 6th grade ELA). However, the 11th grade scores on both ELA and math exams were highly affected by these variables. These results suggest access to technology might be most significant during the later years of primary education. This would largely imply that access to computers and internet becomes more important as curriculum becomes more complex.

No home computer was shown to only significantly affect 11th grade ELA scores. This negative relationship (where more households with no computers lowers ELA scores) is likely caused by the need for a device that allows a student to complete increasingly complex assignments, such as typing papers. Access to a computer allows for the use of programs such as Microsoft® Word, which offers multiple features (spell-check and thesaurus, for example) that can increase a student's ability to complete tasks more thoroughly and correctly. Thus, the more difficult upper-level ELA assignments likely require a more content-friendly interface found on traditional computers or laptops, rather than a cell phone or other device, for assignment completion and success.

Home-wired access had its highest significance for 11th grade math. This finding is surprising because wired access was not significant for math scores in any other grade. Additionally, the coefficient associated with this result is the highest of any technology-based variable tested. This is likely caused by the large increase in the difficulty of math for 11th grade students and a greater need for at-home studying and/or homework. Increased difficulty of content means students may be accessing alternative educational online platforms, such as Khan Academy, explanatory YouTube videos or websites on specific math topics. Home-wired access also showed significance for 6th and 11th grade ELA scores. Similar to the explanation surrounding home computer access and ELA scores, the increased difficulty in curriculum and the necessity for a better screen interface requiring internet access are likely partially responsible for these findings. Use of online resources such as writing labs, bibliography makers and search engines can help students enhance their paper writing and ability to complete assignments, especially when used in conjunction with a home computer.

These findings surrounding the technology-based factors of having no home computer and home-wired access seem to imply access to computers and internet becomes more important as the curriculum becomes more complex, and these factors do significantly affect student test scores. As the impacts of COVID-19 create a greater focus towards at-home education, investments in home computer access and home-wired internet access – especially among higher grades in K-12 schools – can have a meaningful impact on future test scores.

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Extension carries out programs in the broad categories of agriculture, natural resources and environment; family and consumer sciences; 4-H and other youth; and community resource development. Extension staff members live and work among the people they serve to help stimulate and educate Americans to plan ahead and cope with their problems.

Some characteristics of the Cooperative Extension system are:

- The federal, state, and local governments cooperatively share in its financial support and program direction.
- It is administered by the land-grant university as designated by the state legislature through an Extension director.
- Extension programs are nonpolitical, objective, and research-based information.
- It provides practical, problem-oriented education for people of all ages. It is designated to take the knowledge of the university to those persons who do not or cannot participate in the formal classroom instruction of the university.
- It utilizes research from university, government, and other sources to help people make their own decisions.
- More than a million volunteers help multiply the impact of the Extension professional staff.
- It dispenses no funds to the public.
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