Exploratory Question Report

EXECUTIVE SUMMARY

This report is written to address policymakers and education leaders at the state level to improve educational outcomes for students in the public K-12 school system.

Disparities in internet access and technological infrastructure continue to widen the achievement gap in K-12 education. While digital tools and online learning are increasingly essential, students in rural and low-income communities often lack the necessary resources, putting them at a disadvantage.

Research highlights that socioeconomic status, parental education, and household income significantly influence digital access. Students from higher-income, two-parent households have greater access to reliable internet, while those from single-parent or marginalized communities face barriers. The COVID-19 pandemic further exposed these disparities, with students without internet access experiencing measurable declines in academic performance, particularly in the fields of math and science.

While overall access to computers and the internet has improved, gaps remain. In 2023, only 1.42% of American youth aged 3-18 lacked household computer access, yet disparities persist, especially among American Indian/Alaska Native children and lower-income families. Studies suggest that digital access can both enhance and hinder educational success, depending on how technology is utilized.

Addressing these challenges requires targeted interventions such as broadband expansion, affordability programs, and digital literacy initiatives. Without strategic investments, marginalized students will continue to face educational disadvantages, impacting their long-term academic and career prospects. Ensuring equitable access to digital resources is essential for fostering inclusive and effective learning environments.

CONTEXT

For many students, access to high-speed internet, personal devices, and digital literacy skills is essential for completing homework, engaging in virtual learning, and developing the technological proficiency needed for future academic and career success. However, in rural areas and underfunded communities, broadband access remains limited, and many families cannot afford computers or tablets. This results in an uneven playing field where students in wealthier districts gain a significant educational advantage simply due to their ability to connect and engage with digital resources.

Exacerbations to Inequitable Access to Digital Infrastructure During the Pandemic

The COVID-19 pandemic further exposed and exacerbated these inequities. When schools transitioned to remote learning, students in low-income households struggled to participate due to unreliable internet access or the absence of appropriate devices. These challenges not only disrupted student learning but also highlighted the systemic barriers that prevent equitable access to education. As schools shifted to remote learning, students lacking adequate internet connectivity faced significant challenges, leading to measurable declines in academic performance. A meta-analysis examining the pandemic's impact on student achievement found an average learning deficit of about 0.19 standard deviations with losses that were more pronounced in subjects such as mathematics and science (Di Pietro, 2023). Research indicates that students without home internet access during the pandemic typically exhibited lower digital skills, scoring approximately three points lower on a 64-point digital skills scale compared to their peers with internet access (Bauer, 2020). This gap in digital proficiency translates into broader academic challenges, as these students are less able to engage with online learning platforms and resources.

Existing Research on Internet Access and Education

Research on digital inclusion highlights persistent disparities in internet access and usage across demographic and socioeconomic groups. Research suggests that two-parent households with higher income and educational attainment have greater internet access (Chaudhuri, Flamm & Horrigan, 2005; Livingstone & Helsper, 2007; Notten et al., 2009). On the other hand, one-parent households from marginalized communities, such as Black, Latinx, and/or rural communities, face greater barriers to internet services (Chaudhuri, Flamm & Horrigan, 2005; Graves et al., 2021; Notten et al., 2009). Collectively, these studies underscore the role of socioeconomic and demographic factors in shaping digital access and engagement.

What are the implications of this for educational engagement and performance? Some research suggests that access to computers and the internet is associated with higher test scores and educational performance, particularly in science (Spiezia, 2010; Wainer, Vieira, & Melguizo, 2015; Kubiatko & Vlckova, 2010; Luu & Freeman, 2011; Machin, McNally, & Silva, 2007). Other research, however, finds that internet and computer access may hinder educational success, particularly after controlling for factors that influence both. Research suggests that access to computers and the internet is associated with lower student achievement, particularly in math and reading (Fuchs & Woessmann, 2004; Vigdor, Ladd, & Martinez, 2014). Taken together, this research suggests that the benefits of computer and internet access may depend on how these technologies are used.

It is therefore unsurprising that interventions aimed at increasing computer and internet access have mixed success. Some studies find that interventions expanding computer and internet access improve student performance in subjects like English and science (Machin, McNally, and Silva 2007); other studies find that computer and internet access have no impact on student

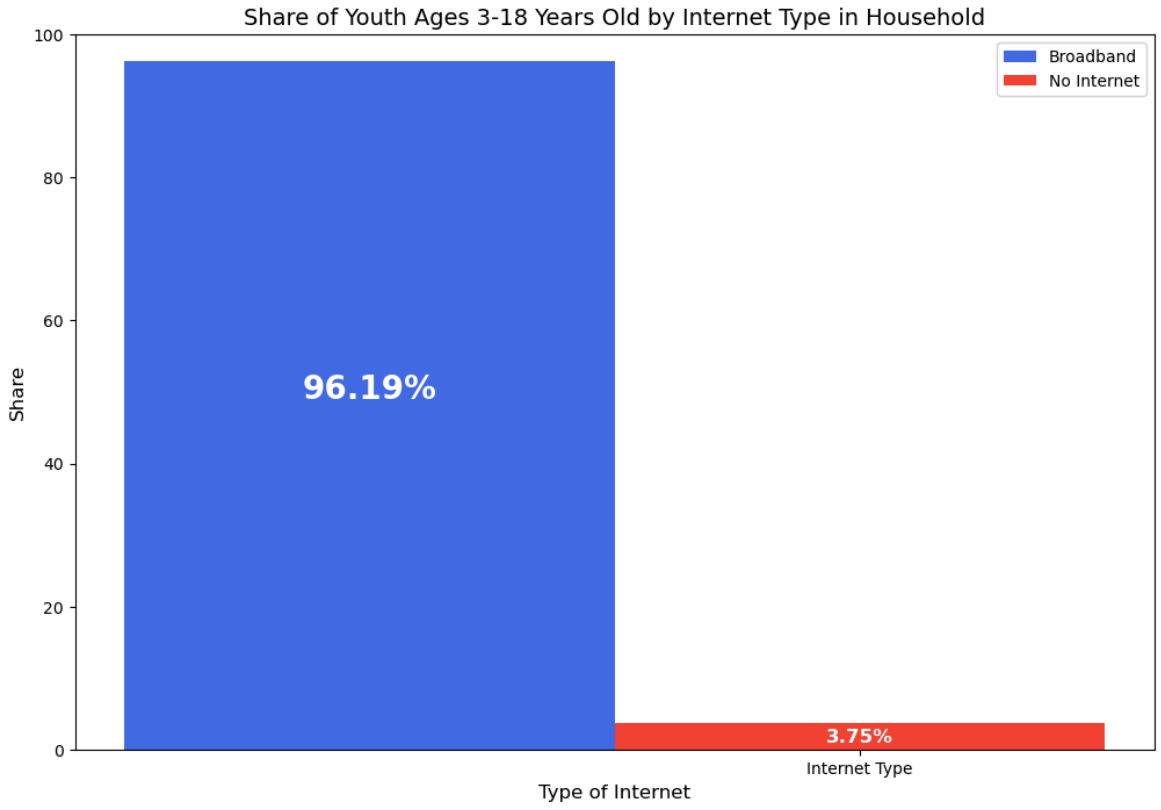
performance in subjects like mathematics and language (Cristia et al., 2017; Goolsbee & Guryan, 2006). Together, these studies highlight that providing computers and internet access alone may not be sufficient to improve academic performance.

RESULTS

Computer and Internet Use Nationwide

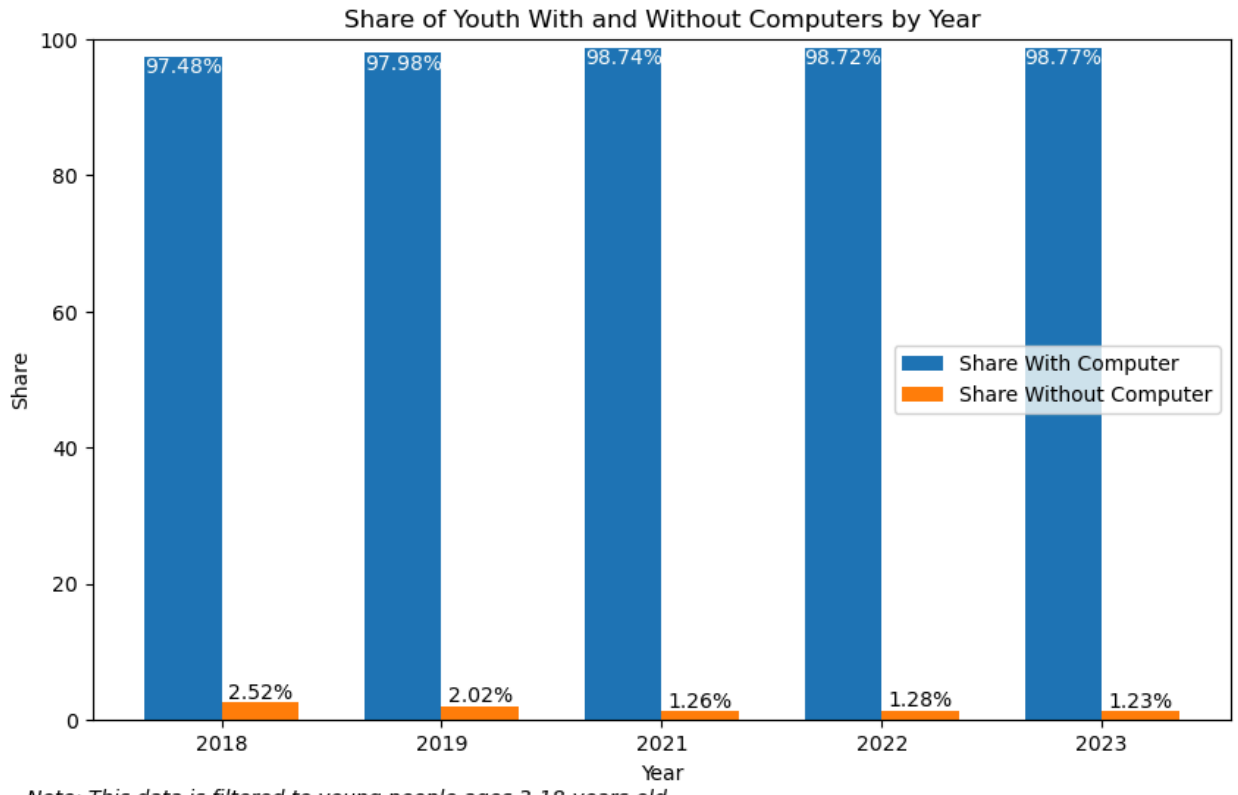
To further investigate the current state of youth computer and internet access in households in the United States, our team analyzed data from the U.S. Census Bureau. The widespread adoption of household computers has greatly increased in the past three decades. Currently, only a small proportion of American youth do not have access to a computer in their household. According to the U.S. Census Bureau Current Population Survey (CPS), the share of Americans who reported having a computer in their household has risen from 8 percent of households in 1984 to 89 percent in 2016 (The CPS began collecting data about computer use in 1984). (Ryan, 2018)

According to the 2018-2023 5-Year American Community Survey sample, 1.42% of American youth ages 3-18 do not have access to a computer in their household.



Note: This data is filtered to young people who had a computer in their household.
SOURCE: U.S. Department of Commerce, Census Bureau, American Community Survey (ACS) 5-Year, 2023

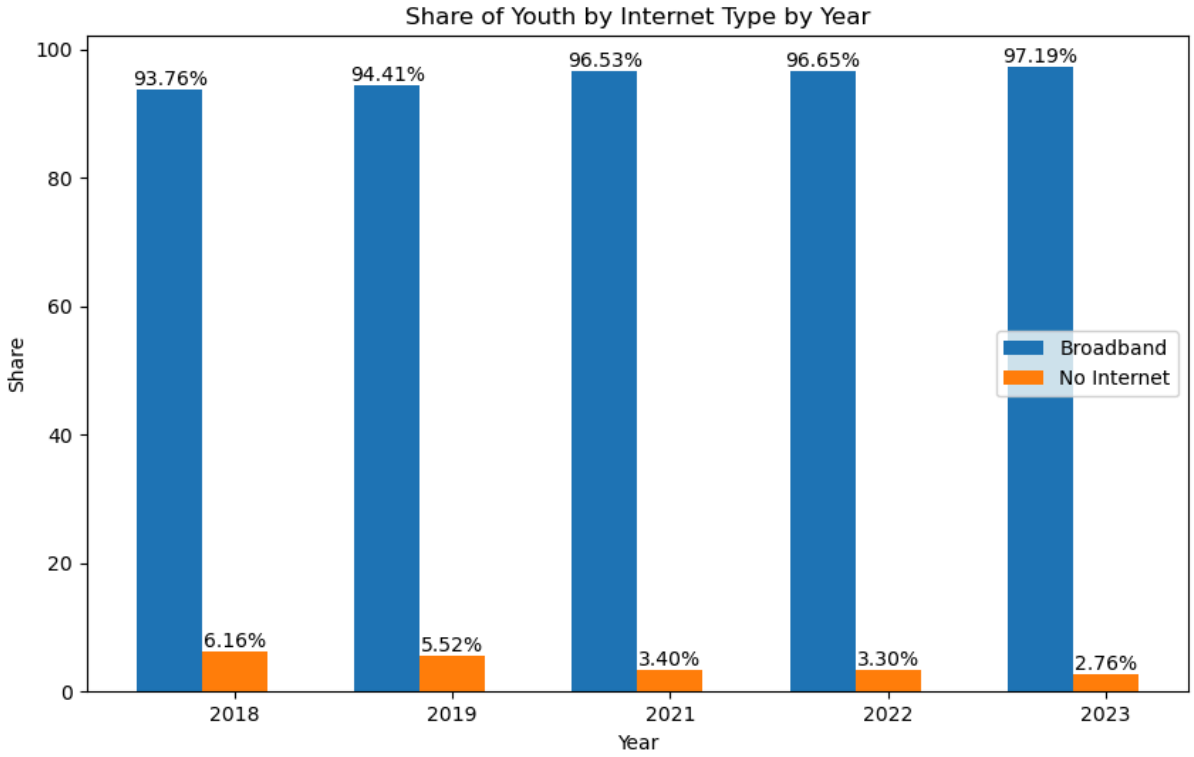
Of the approximately 98.6% of American youth who have a computer in their household, approximately 3.75% do not have an internet subscription. 96.19% of American youth with a computer in their household reported that they had a broadband internet subscription, and < 0.01% indicated that they had a dial-up internet subscription.



Note: This data is filtered to young people ages 3-18-years-old.
SOURCE: U.S. Department of Commerce, Census Bureau, American Community Survey (ACS) 5-Year, 2023

Upon investigation into the trend of youth access to computers in the household by year, we observed a decline in the share of young people who reported that they did not have a computer in the household.

In 2018, 2.52% of young people ages 3-18 reported that they did not have a computer in their household. For the years following the beginning of the COVID-19 pandemic in March 2020, these shares are even lower, potentially indicating that a reduction in in-person activities encouraged more households to invest in household computers. In 2021, 2022, and 2023, less than 2% of young people ages 3-18 reported that they did not have a computer in their household. Data for the year 2020 is unavailable, as the 2020 1-Year American Community Survey data was not released by the U.S. Census Bureau due to the impact of the COVID-19 pandemic on the Bureau's data collection efforts.



Note: This data is filtered to young people ages 3-18-years-old who had a computer in their household.
SOURCE: U.S. Department of Commerce, Census Bureau, American Community Survey (ACS) 5-Year, 2023

For young people who reported having a computer in their household, the share of youth who said they do not have an internet subscription has decreased since 2018. Before the start of the COVID-19 pandemic, 6.2% of youth in 2018 and 5.5% of youth in 2019 who had a computer in their household said they did not have an internet subscription. In the years following 2020, this share had roughly halved, with less than 4% of young people with computers in their household reporting that they did not have an internet subscription.

The share of youth who reported having access to the Internet in their household differed across racial/ethnic groups, parental education, and household income. While over 95% of children across most racial/ethnic groups reported having home internet access in the 2021 American Community Survey, this share was only 89% for American Indian/Alaska Native children. Home internet access was also highest for young people with higher levels of parental educational attainment. Approximately 99% of youth whose parents had attained a Bachelor's degree or higher reported having internet access, compared to 91% of youth whose parents had less than a high school degree. Finally, there were also reported disparities in home internet across different socioeconomic groups. Despite 98% of youth from families in the highest income quarter reported that they had home internet access, only 85% of youth from families in the lowest income quarter said they had home internet access. (National Center for Education Statistics,

2023) These observations echo broader findings in the literature which conclude that socioeconomic factors impact youth computer and internet access.

Although a majority of young people reported having a computer in their household and home internet access, nearly 4% of youth ages 3-18-years-old said they did not have access to a computer in 2023. Among young people with a computer in their household, there are varying levels of home internet access by race/ethnicity, parental education, and household income. These disparities could negatively impact the ability of certain groups of students to achieve the same educational outcomes and level of performance as their peers.

DISCUSSION

Disparities in Internet Access

Research on digital inclusion highlights persistent disparities in internet access and usage across demographic and socioeconomic groups. The digital divide has found its way at the intersection of technology and education in what some have called the "homework gap", where some school-age children lack home access to computers and the internet. Chaudhuri, Flamm, and Horrigan (2005) demonstrate that income and educational attainment are the strongest predictors of internet access in the United States, with African Americans and Hispanics being less likely to subscribe to internet services than other racial groups. Livingstone and Helsper (2007) identify inequalities in digital access and internet use among UK youth, showing that socioeconomic status influences both the quality and depth of online engagement. Graves et al. (2021) find that rural students have significantly lower access to internet-enabled devices for online learning and face greater broadband connectivity barriers compared to their urban counterparts.

Extending this analysis globally, Notten et al. (2009) use data from 30 countries to examine digital inequalities among adolescents, finding that those from higher socioeconomic backgrounds and two-parent households are more likely to have home internet access and are more likely to use it for informational purposes. Meanwhile, adolescents from single-parent families have lower home internet access and are more likely to use it for communication and gaming. Collectively, these studies underscore the role of socioeconomic and demographic factors in shaping digital access and engagement, with implications for education.

Affordability (Not Lacking Infrastructure) Is the Issue

Affordability, not the lack of high-speed broadband infrastructure, is the biggest reason millions of students are still without home internet access. Nearly two-thirds of offline households have access to home broadband connections, but just can't cover the cost. An estimated 8.4 million households with children (or 16.9 million children under the age of 18) lack high-speed home

internet (EdWeek 2021). Students of color experience the homework gap disproportionately, with one in three Black, Latino, and American Indian/Alaska native households lacking such internet access. Using data from the 2019 ACS survey, researchers at Future Ready (2020), a nonprofit committed to expanding equitable educational opportunities for students of color, found that children in these households are more likely than their White peers to be disconnected from online learning, an increasingly inseparable part of K-12 education. Additionally, 3.6 million households do not have a computer, putting nearly 7.3 million children at an academic disadvantage. Access to connections on larger devices, like laptops and even tablets, are crucial for student success, since relying on a mobile phone is more ineffective for completing digital assignments and participating in online classes. When the data is broken down by income, 23% of all households lack high-speed internet, unsurprisingly comprising more households with relatively low incomes. Finally, households without high-speed internet are much more likely to be in rural areas, with acute shortages in states like Arkansas, Louisiana, Mississippi, Oklahoma, and Texas.

Effect on Education Outcomes

Research on the impact of computer and internet access on educational outcomes presents mixed results. Some research suggests that access to information and communications technology (ICT) have a positive effect on learning. For example, Spiezia (2010) finds that computer use is positively associated with student achievement in science and that the effect is stronger when computers are used at home rather than at school. Similarly, Wainer, Vieira, and Melguizo (2015) demonstrate a significant positive relationship between home computer access and test scores for Brazilian primary students, though the impact of internet access is smaller and varies by socioeconomic status. Kubiatko and Vlckova (2010) find that Czech students with ICT score higher on science knowledge tests, particularly when ICT use is integrated into educational activities. Likewise, Luu and Freeman (2011) find that Canadian and Australian students with ICT exhibit higher scientific literacy scores. Finally, Machin, McNally, and Silva (2007) find a positive impact of ICT on primary school performance in English and science, but not in mathematics.

Other research suggests that internet and computer access may hinder educational success after controlling for factors that influence both access and educational success. For example, Fuchs and Woessmann (2004) initially observe a positive correlation between student achievement and computer availability at home and school, but after controlling for family background, the effect of home computers turns negative, suggesting that computer access may serve as a distraction from academic learning. Vigdor, Ladd, and Martinez (2014) show that home computer access is associated with modest but persistent declines in math and reading test scores among North Carolina public school students, an effect that is exacerbated by socioeconomic disparities.

Taken together, this research suggests that the benefits of computer and internet access may depend on how these technologies are used.

The influence of lacking home-wired Internet access also has distinct impacts at different grade levels. Lacking access to home-wired Internet and to larger electronic devices like laptops, computers, and even tablets tends to hit students harder as they advance to difficult curriculum – and, with it, increasingly complex homework assignments requiring tools from word processing software and bibliography makers to online platforms like Khan Academy and YouTube. In a study evaluating Oklahoma school districts, researchers at Oklahoma State University (2020) found that student proficiency scores in mathematics and English language arts (ELA) were higher for districts in the top quartile of access to wired internet at home when compared to those in the lowest quartile – a trend that held true for all grades analyzed. Multiple regressions were performed for third-, sixth-, and 11th-grade ELA and math exam performance. The computer and internet-based coefficients were only significantly related to school performance at certain grade levels. The percentage of households with no home computer and Internet access were largely insignificant in the 3rd and 6th grades. However, the 11th grade scores on both ELA and math exams were highly affected by the computer and internet variables, implying that access to technology might be most significant during the later years of primary education (and more important in late middle school and high school). No home computer was shown to only significantly affect 11th grade ELA scores, likely caused by the need for a larger device that allows a student to complete upper-level ELA assignments like writing essays and longer research papers. Meanwhile, home-wired Internet access had its highest significance for 11th grade math, implying that increased difficulty of content meant that students may need access to educational online platforms like Khan Academy, YouTube, or websites on specific math topics. Home-wired access also showed significance for 6th and 11th grade ELA scores for the same reason: with an increased difficulty in curriculum, use of online resources like writing labs and bibliography makers helped students with home-wired Internet successfully complete their ELA assignments.

Interventions and Impact Evaluation

Interventions aimed at increasing access to computers and the Internet in schools have had mixed effects on educational outcomes. Goolsbee and Guryan (2006) evaluate the impact of the U.S. government's E-Rate program, which subsidized internet infrastructure in public schools, particularly benefiting urban and minority-serving institutions. While the program successfully expanded internet access in classrooms, the study finds no significant impact on student performance, at least in the short term. Similarly, Machin, McNally, and Silva (2007) analyze the effects of increased ICT funding in English schools and find that while investment in technology improves student performance in English and Science, it has no measurable impact on Mathematics. Finally, Cristia et al. (2017) assess the One Laptop per Child (OLPC) program in

rural Peru, which dramatically increased student access to computers both at school and at home. While the initiative significantly expanded computer use, the study finds no effect on test scores in Math and Language. Together, these studies highlight that providing computers and internet access alone is not sufficient to improve academic outcomes.

CONCLUSION

Bridging the digital divide is critical for ensuring equal educational opportunities for all students. While progress has been made in expanding digital access, persistent disparities remain a barrier to academic success for marginalized communities. A comprehensive approach that includes policy reforms, infrastructure investments, and targeted support programs is necessary to close this gap. By prioritizing equitable access to technology, we can create a more inclusive education system that empowers all students to succeed in the digital age.

Investments in digital literacy and responsible technology use must accompany increased access to prevent potential distractions and ensure students benefit academically. Schools, policymakers, and private sector partners must collaborate to develop initiatives that provide not just hardware and connectivity but also the necessary training and support to maximize their educational impact. Addressing these challenges holistically will help prepare students with the digital skills essential for success in higher education and the workforce. Ensuring all students have equal opportunities to learn and grow in a technologically advancing world is vital to fostering long-term social and economic equity.

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