

# Barriers to Digital Equity: An Analysis of Socioeconomic Disparities in Educational Technology Adoption

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## ABSTRACT

A major criticism of educational technology initiatives is that they tend to focus solely on obtaining hardware, and there is also concern that intended equity gains may not occur. To gain credibility and support for any large-scale technology-based digital integration effort in a public school system, it is crucial to demonstrate that an initiative fosters real-world technological proficiency. This systematic review paper outlines a model that evaluates whether current education policy effectively addresses the multifaceted nature of the contemporary digital divide. The recent introduction of Artificial Intelligence (AI) into American schools serves as the case study for this investigation. By synthesizing the most prominent extant literature, this research uses a comprehensive sociological approach to examine how educational technologies are implemented based upon the theory of the "second-level" digital divide. As such, the results of this study offer a framework for school administrators and policymakers who are contemplating adopting new educational technologies. The study's findings indicate that to achieve true digital equality, it is necessary to shift from "access-first" to "proficiency-first" paradigms so that all students have equal opportunities to benefit from educational technology, moving beyond the baseline requirement of internet access. The key conclusions are: (i) a distinct usage gap exists, with affluent students utilizing AI for critical thinking while less affluent students miss these pedagogical benefits; (ii) the proliferation of premium, subscription-based AI products exacerbates a tiered system of academic advantage; and (iii) interventions external to hardware distribution, including robust teacher training and targeted AI literacy programs, boost the overall value of educational technology.

## INTRODUCTION

The use of digital technologies has drastically changed the way teachers instruct and students learn in U.S. schools. In response to the COVID-19 pandemic, schools rapidly shifted to online learning models which resulted in a significant number of students attending school both virtually or part-time, permanently changing the educational environment (Auxier & Anderson, 2020; Ali & Chandra, 2021). During the early 2020s, many schools provided computers for students funded by emergency programs

May 2026

Vol 7. No 1.

sponsored by the federal government allowing for greater access to remote learning (Education Commission of the States, 2020). Most recently, schools have started using new types of educational technology including generative artificial intelligence and adaptive learning software to increase student engagement and improve student outcomes (Forster et al., 2025; BERA, 2024).

As a review paper, this article provides an overview of highly influential current research examining the digital divide in the United States. The goal of this review is to evaluate whether the preponderance of leading research supports the conclusion that the digital divide is evolving and compounding, rather than shrinking. Focusing on three major areas of inquiry, this review asks:

1. In what ways has the shift to virtual learning highlighted the continued negative impacts of the "homework gap" on academic achievement and college-readiness?
2. What structural barriers limit students who attend schools located in low-income communities from developing higher levels of digital literacy and actively utilizing those skills?
3. How will the increasing commercialization of and costs associated with generative AI further exacerbate pre-existing economic inequities experienced by students and families?

The paper argues that the inequalities identified throughout the extant literature are not separate hardware issues but are instead linked together creating a self-reinforcing system of inequality via institutional and socio-economic pathways. As a result, achieving real digital equity will require a systemic solution based on proficiency development and comprehensive policy reforms that address multiple dimensions of digital equity beyond just device distribution.

## **METHODOLOGY**

To answer those research questions, this study used a targeted literature review to gather evidence. Using Google Scholar and recognized institutional policy repositories, primary literature was found. Targeted search terms such as "homework gap," "second-level digital divide," "socioeconomic educational disparities," and "generative AI in education" were used. To create an empirical basis for the primary research question by identifying those findings that are supported by the largest number of authors, it was necessary to assess how many times each article had been cited, and to evaluate whether or not they represent significant contributions to our understanding of the digital divide. The methodology used did not attempt to compile a list of studies supporting one particular conclusion to artificially create a consensus among researchers. Instead, as much as possible, all articles with high levels of citations and perceived significance were included in order to see if there is a consensus of opinion (as evidenced through citations) about the trends in the digital divide from major authors who have written about this topic. To accurately reflect the evolution of artificial intelligence usage since the onset of the COVID-19 pandemic, the analysis included studies published between 2019 and 2026. Older conceptual theories (such as van Dijk's foundational work on the second-level divide) were only referenced as needed to

May 2026

Vol 7. No 1.

establish baseline definitions. Articles were selected based on whether they were directly applicable to the research objectives, used large-scale demographic studies or other empirically-based data, and focused primarily on American K-12 and early college learning environments. To reconcile any early academic disagreements regarding the long-term effectiveness of 1:1 hardware programs, this review prioritized longitudinal data that tracked student outcomes over time. Adult corporate training and/or general use of technology outside of an educational environment was excluded. This review is built upon 16 primary resources that include academic journals and national policy documents. As opposed to listing all the studies chronologically, the synthesis of literature occurred thematically with the purpose of developing a comprehensive thematic analysis of how the digital divide has evolved.

## **RESULTS**

### **The Infrastructure Gap and Homework Gap**

#### *Federal Response to COVID-19 School Closures and the Shift Towards 1:1 Computing*

In March 2020, at the onset of the COVID-19 pandemic, there were over 50 million K-12 students transitioned to remote instruction for extended periods. To continue providing students with an opportunity to learn while away from their classrooms, Congress passed several bills including the CARES Act. This legislation provided billions of dollars to school districts to fund the acquisition of computers and other devices to enable students to do their schoolwork remotely. There were many reasons why a 1:1 computing model became a priority in addition to enabling students to work from home. However, one reason was to provide all students with equitable access to the same resources regardless of where they lived. Unfortunately, this effort was met with an unexpected challenge. Many students found that even though they had a device to take home to do their schoolwork, many homes did not have enough bandwidth to perform their schoolwork using streaming video platforms. This lack of sufficient bandwidth for educational tasks became widely known as the “Homework Gap.” The Homework Gap describes the educational disadvantage experienced by those students who are required to complete schoolwork dependent upon internet availability but lack access to reliable internet connectivity at home.

#### *Uneven Impact of the Homework Gap on Low-Income Families and Communities of Color*

There was little doubt among educators that the Homework Gap would negatively impact students’ ability to complete their schoolwork. Students unable to connect to the Internet at home regularly earned lower grades and completed fewer assignments compared to their peers who could rely on fast and affordable broadband services (All4Ed, 2020). Unlike other forms of

digital inequity, the Homework Gap is not distributed equally among populations. Rather, it disproportionately impacts low-income families and communities of color. Studies show that about 25% of Black teenagers and 17% of Hispanic teenagers reported being unable to complete homework due to either lacking a computer or adequate internet connection (Auxier & Anderson, 2020). Additional demographic analysis also reveals a similar pattern of disproportionate negative impact. According to recent studies, approximately 30% of Black, Latino, and Native American families lacked reliable and consistent internet available in their homes to enable remote learning during the pandemic (Ali & Chandra, 2021). Interestingly, even in economically strong technology hubs such as Austin, Texas, high-speed internet has become so important that it now functions as a type of “techno-capital” that enables some students to attend better schools than others based on where they live (Santillana et al., 2020).

## **The Usage Gap and Digital Literacy**

### ***Emerging Second-Level Divide***

Simply addressing the issues related to hardware and connectivity provides only part of the solution to digital inequities. Another barrier that exists once students have successfully logged onto the internet is referred to as the second-level divide (Hargittai & Hinnant, 2008) by sociologists. According to Hargittai and Hinnant’s theory of the second-level divide, the digital divide should be understood as a two-layered issue: the first layer refers to whether people possess computers and the second layer refers to how skilled users are in accessing information online. A substantial body of longitudinal research demonstrates that simply giving students computers does not automatically produce digitally literate or proficient users (van Dijk, 2020). Absent formal instruction, providing devices for students only shifts the location of the inequalities from the physical classroom environment to the digital interface.

### ***Consumers vs. Creators***

The second-level divide manifests itself clearly when comparing students attending low-income and high-income school districts. In many low-income schools, technology is used mainly for simple remedial purposes. Students in these schools are generally conditioned to passively consume technology by clicking through multiple choice questions or watching pre-recorded educational videos. On the other hand, students attending affluent schools utilize technology to create content. High-income schools equip their students with technology that enables them to write code, create web pages, and analyze large data sets (Warschauer & Matuchniak, 2020). Differences in use extend further when considering intersections of race/ethnicity and SES. Students from historically marginalized communities often miss opportunities to develop sophisticated technological skills simply because their schools lack funding and/or infrastructure needed to teach advanced digital curriculum (Ritzhaupt et al., 2013).

### ***Role of Teacher Effectiveness in Creating Usage Gaps***

May 2026

Vol 7. No 1.

Teachers' own levels of digital literacy play a central role in creating usage gaps. Educators who are not thoroughly trained in current forms of educational technology will be ineffective at helping students move from consuming technology passively, i.e. using technology to answer drill-based questions, to creatively applying it. Research consistently demonstrates that a teacher's pedagogical beliefs and personal digital confidence directly dictate the intellectual value placed on technology use within their classrooms (Ertmer & Ottenbreit-Leftwich, 2010). Therefore, if school district budgets choose to focus on buying screens for their classrooms versus developing the professionals responsible for teaching in those classrooms then what results is nothing short of a very costly digital worksheet as opposed to a fundamentally transformative educational experience.

## **Artificial Intelligence Divide**

### **Expensive Subscription-Based AI Models: Creating New Disparities**

Digital divides are shifting rapidly as artificial intelligence (AI) begins entering mainstream educational settings. Generative AI is rapidly becoming an integral component of normal educational practice. At the same time however, AI is creating a new tier of academic disparities. The most sophisticated AI models capable of performing meaningful academic work are increasingly operating behind expensive monthly subscription walls. Therefore, when generative AI enters into the realm of premium subscriptions it operates as a luxury good which wealthy families alone may afford access to (BERA, 2024). This financial barrier permits wealthier children to delegate difficult brainstorming, editing, and structuring processes to advanced algorithms thereby producing artificially increased standards of academic production relative to non-AI enabled low-income students.

### ***College Readiness and Future Employment Opportunities: Negative Consequences***

As students prepare for post-secondary education this new AI divide is especially detrimental. Data released recently shows that first generation college students are much less likely than continuing-generation students whose families hold greater income and education attainment backgrounds (WGU Labs, 2024), to use AI in assisting with their coursework. Consequently, this reluctance or lack of access poses serious implications for widening existing college graduation gaps. Economists warn that failing to democratize access to AI will result in severe long-term macroeconomic consequences. As economies enter into a highly automated “intelligent age,” students who graduate without effective AI literacy will encounter severe barriers in acquiring upwardly mobile jobs (World Economic Forum, 2025).

### ***Potential for AI as an Educational Equalizer***

While AI creates new challenges for achieving equality in education it need not be an instrument of inequality. By engaging proactively in efforts to promote accessibility and training for public education systems, AI has the potential for accelerating learning for disadvantaged students. Experimental studies have demonstrated that when students with lower baseline writing abilities are provided with equal access to generative AI and instructed on how to write prompts for the AI program, the quality of their writing

May 2026

Vol 7. No 1.

increases substantially resulting in closing of the gap between their writing quality and that of their peers who are able to write better (Forster et al., 2025). Achieving this goal will require coordinated actions by state and local policymakers. Policymakers must establish plans that assure universal digital access for families and provide them with the training they need to effectively use digital technologies (NCFR, 2025). International examples of policies regarding digital education may serve as useful templates for U.S. administrators seeking solutions that address digital inequity (OECD, 2023).

## **DISCUSSION**

**Interrelated Disparities** Although educational technology has been studied extensively within the U.S., there is a significant and overarching theme to emerge throughout the literature – the current digital divide in the United States is a multifaceted and interdependent societal and institutional issue rather than an isolated series of hardware deficits (Ritzhaupt et al., 2013; Hargittai & Hinnant, 2008; Warschauer & Matuchniak, 2020). Broadband reliability and unequal use of educational software applications, and the proliferation of artificial intelligence have created disproportionate barriers for disadvantaged students who will experience compounding inequity which cannot be resolved merely through the distribution of hardware.

In essence, while individual analyses are able to clearly outline the Homework Gap, the Usage Gap, and/or the AI Divide, analyzing all three collectively identifies a fundamental truth about how the digital divide serves as a "pipeline" of increasingly severe exclusion for individuals based upon their social status. In addition to illustrating how fixing an earlier stage of the divide can inadvertently accelerate inequality by failing to anticipate the next stage, it also illustrates how granting affluent students access to basic hardware alone (without including training) enables them to quickly transition to premium tools above an increasingly wide base of underprivileged students, thus increasing the ultimate achievement gap at a greater rate than previously.

The socioeconomic structures that produce and maintain each of these inequities are mutually supportive. Inequitable infrastructure such as the "Homework Gap" hinders a student's consistent engagement with digital environments thereby impeding early technical competency (Santillana et al., 2020) and limiting the development of higher-level digital literacy. This limitation traps low-income students in a passive role of consuming technology, as opposed to engaging in interactive technical experiences. As a result, students experiencing inequitable opportunities will be unable to take full advantage of the emerging generation of sophisticated technologies including generative AI entering into educational settings. Not only will these students lack the economic means to purchase premium subscription based versions but also, the baseline digital literacy to utilize them effectively (Forster et al., 2025; BERA, 2024).

This creates a self-reinforcing cycle where students with limited resources show less academic and technological achievement. Schools frequently misattribute this as a function of cognitive ability rather than opportunity, providing additional justification for schools to invest fewer resources in digitally rich curricular options for these same population segments (WGU Labs, 2024; Ritzhaupt et al., 2013). Thus, without regulation, the rapid pace at which advanced technologies are being incorporated into educational

May 2026

Vol 7. No 1.

settings will continue to disproportionately benefit affluent students and expand the educational college-readiness gap for underrepresented groups.

### ***Multilevel Equity Framework***

To begin to address the compounding inequities described above requires collaborative efforts across multiple levels of the system rather than relying solely on individual device-based solutions.

- ***Policy-making/Governance:*** Federal and state governments must define high-speed Internet as a public utility rather than a private commodity and create laws ensuring universal access to broadband for every household with school-age children (NCFR, 2025). Additionally, funding formulas should require school districts receiving technological grants to report how they plan to support digital equity using state funds to promote proficiency rather than simply provide access (OECD, 2023).
- ***Curriculum Design/Implementation:*** Districts must transition away from stand-alone computer literacy courses and toward fully integrated digital curricula. Creation of active technological products such as coding, AI prompts, etc. should be embedded into subject areas such as English and Mathematics. Creating a framework that supports students' development of critical thinking skills needed to succeed in an increasingly automated work environment provides students with long-term success regardless of technological advancements (World Economic Forum, 2025; Warschauer & Matuchniak, 2020).
- ***Teacher Preparation/Education:*** Teacher preparation programs funded through university credentialing processes and local school district needs assessments must incorporate advanced digital literacy into their programs. Ensuring teachers receive targeted ongoing professional development enables teachers to develop pedagogically-sound approaches to integrate advanced, creative technologies into their instructional practices (Ertmer & Ottenbreit-Leftwich, 2010).
- ***Corporate Responsibility and Collaborations:*** Developers of educational technology and companies utilizing AI must partner with public education systems to eliminate financial barriers associated with premium generative tools. By establishing tiered pricing models for public K12 school districts for educational AI, corporate interests can help ensure that highly advanced educational AI is accessible to all socio-economic demographics (BERA, 2024).

## **CONCLUSION**

Public education in the United States is at a momentous time in terms of technology. The rapid introduction of one-to-one student computing via an unprecedented amount of federal funding due to COVID-19 created a massive impetus for schools to integrate advanced software into classrooms. As

May 2026

Vol 7, No 1.

evidenced by the synthesis of research contained within this review, however, a preponderance of the most influential literature confirms that significant inequities exist in multiple dimensions related to the current state of technological advancement in public education. Specifically, there exists a homework gap which will continue to disadvantage students who do not have reliable access to broadband. There also continues to exist a secondary level usage gap where affluent students are actively creating content with their technologies while low-income students are relegated to passively consuming them. Finally, the unregulated development of generative artificial intelligence may create an environment where the academic performance of children from affluent families appears artificially inflated when compared to those from lower-income families.

These persistent gaps are not simply technological failures and reflect deeper interrelated sociological, economic, and institutional challenges. Providing individuals with physical devices alone has been shown to be an insufficient means to resolve these systemic issues. True digital equity will require collective action across multiple levels including both legislative policies and the provision of fully-integrated digital curriculum to educators through broad-based corporate accountability. School leaders need to move away from the 'access first' approach and toward a 'proficiency first' model. It is only through this type of coordinated commitment that we can provide the opportunity for our digitally advancing world to serve as a vehicle for upward social mobility and not as a source for continued academic disenfranchisement.

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May 2026

Vol 7. No 1.

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