Education Open Data Challenge: Broadband Access and Usage Among K-12 Public School Students

Executive Summary

To investigate digital inequality among K-12 public school students within the United States, we utilized open data to assess and evaluate this issue through socio-technical and economic perspectives. The lack of comparable measures for the U.S. hinders our understanding of the digital divide across counties and states. Two quantitative measures derived from open datasets were designed to aid decision-making and policy recommendation for practitioners: a county Students' Digital Opportunity (SDO) composite measure and a county Benefit-Cost Ratio.

Our research objectives for this project include: 1) to evaluate the relationship between terrestrial broadband availability, usage, and costs at the county level across the United States, 2) to assess how terrestrial broadband availability, usage, speed, and cost varies at the county level, 3) to create measures to illustrate how student digital opportunity varies by county K-12 public schools, and 4) to estimate societal benefit-cost ratios to inform investment strategies between public and private sectors.

The Students' Digital Opportunity (SDO) is a composite measure to represent the four components of digital connectivity: access, usage, speed, and ownership of digital devices. The design of the SDO was informed by former theoretical framework on the digital divide. The SDO can be treated as the "pre-requisite" in terms of connectivity before students can tap into existing digital resources in their environment to take full advantage of online learning. The SDO composite measure is estimated for each county in the United States.

A benefit-cost analysis was conducted to estimate a benefit-cost ratio at the county level for decision- making in resource allocation. The costs and benefits are derived from a social perspective, meaning the costs and benefits would not just accrue to governments or internet providers, but to many groups in society as a whole. This allows us to assess whether increased access and connection would produce large enough educational benefits, by geographic area, subject to the region's estimated cost constraints.

We summarize our major findings as follows.

1. The cost of broadband subscription is not a good predictor of access and usage due to the different pricing strategies of internet service providers (ISP) used in areas that have competition vs. less/no competition.
2. Broadband availability is correlated with usage; however, it is not a linear relationship.
3. Internet quality or speed is inversely correlated with rurality, meaning rural areas continue to have access to lower speed ranges.
4. The reported broadband availability from FCC is not a reliable way to determine true options for customers to subscribe to broadband. For example, based on where you live, you may be limited to only choosing fiber optics vs. cable in urban areas. However, fiber optics and cable are not the same kinds of technology.

5. Differences in technology equipment and periodic disruption of broadband internet, regardless of the price paid for the expected speed, are other main factors driving the digital divide.

We suggest differentiated solutions to address short-term and long-term needs for digital connectivity and technology to address the digital divide. Our philosophy is to take an inclusive approach where socio-technical conditions and economic development are both considered. Investments between public and private partnerships can address immediate and intermediate needs at the school level. A broader, longer-term need is to provide support at the community level where other socio-psychological factors (e.g., culture, attitudes, and beliefs) play a role in how people are participating and utilizing digital infrastructure.

First, we suggest using the SDO measure for progress monitoring and program evaluation, where the benefit-cost ratio can inform economic barriers and inform cost-effective solutions.

1. For schools located in areas that lack digital infrastructure, public and private investment partnerships should focus on reliable and affordable broadband access.
2. To ensure content is available and accessible to students, an important strategy is to focus on allowing multi-mode options for learning. Content creators and online learning platforms should have flexible content options due to bandwidth constraints and different device types available to teachers and students.

From a long-term perspective, the human aspects or factors will need extended investment to see results. Maintenance costs for technology and infrastructure should be considered to keep up with changes in technological development.

1. Low-income families tend to have low school/community engagement. This may require utilization of social networks and grassroots efforts to influence families. Currently, in the U.S., there are nonprofit organizations and private foundations that play a role in providing informal learning with technology for students outside of the classroom and upskilling for adults.
2. Digital infrastructure and technology equipment should be budgeted as part of the ongoing cost at the school levels; businesses can help decision-makers at the school or district level to understand maintenance costs for sustainable technology programs.

To conclude, we recognize the lack of comparative measures, as well as a comprehensive assessment of digital connectivity beyond broadband access in the United States. The new Students' Digital Opportunity (SDO) composite measure provides an understanding of digital opportunity for K-12 public school students across counties and states on their relative position in digital connectivity. Our benefit-cost analysis provides a clear way of targeting investment according to varying priority levels. The determination of return on investment, by county, could be valuable for policy makers and community members to partner with federal, state, and local funders and broadband businesses. Our results bridge the strength of data science, education, and economic research. We plan to continue future research on this work by collaborating with local organizations to further understand their needs.

Three interactive maps showing county indicators for: 1) the SDO variable, 2) broadband pricing and usage, and 3) benefit-cost ratios can be found at their respective embedded hyperlinks within this summary.

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