RAND

Research Report

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Assessing the Employment Impacts of Digital Upskilling for Low-Tech Adults

Results from a Pilot Study

For most people in the United States, computers and the internet have become indispensable aspects of daily life. Despite this, 33 percent of U.S. adults do not use computers, and 21 percent do not use the internet at home. Although some people remain disconnected from digital technologies by choice, many lack the resources and skills to use them.

KEY FINDINGS

- The lack of foundational digital literacy skills remains one of the primary reasons why individuals do not access the internet, even as costs and other barriers to digital access have fallen.
- Following completion of nonprofit Byte Back's job-oriented Computer Foundations 1 course, students' daily computer use doubled, students' perceived computer proficiency rose significantly, and students exhibited considerable improvements in their labor market status. Their employment rates nearly tripled, suggesting that foundational digital literacy training provided clear initial benefits even without awarding advanced technical certifications. Although some of this increase might be due to concurrent participation in employment-related services, several tests suggest that Byte Back likely played an important role.
- Despite these employment gains, nearly all respondents of our survey said that they were still actively searching for jobs. This suggests that, although foundational digital skills helped respondents break into the labor market, most remained in search of better jobs.
- A plurality of respondents were between the ages of 25 and 34, suggesting that even young workers could benefit from foundational digital-skills training.

Digital Divide Statistics from the Current Population Survey

We made our calculations using national statistics that come from the Computer and Internet Use Supplement of the U.S. Census Bureau's Current Population Survey (CPS), a critical source of survey data capturing a wide variety of individual and household characteristics, including demographics, socioeconomic status, labor-force characteristics, health and disability status, and much more. Roughly every two years, the U.S. Census Bureau administers a Computer and Internet Use Supplement survey, or a set of additional questions on access to technology and the internet. The U.S. Census Bureau surveys a nationally representative sample of approximately 50,000 households, collecting detailed information on device ownership, internet access, and broader attitudes toward technology and the internet. Data from this supplement can be accessed in a condensed form with visualizations from the National Telecommunications and Information Administration (NTIA) data explorer (NTIA, 2024).

Research shows that broadband internet access improves labor market outcomes (Zuo, 2021; Hjort and Poulsen, 2019) and education outcomes (Bacher-Hicks, Goodman, and Mulhern, 2021; Campbell, 2024), increases access to government services (Zuo and Powell, 2023), and helps households save money (Dolfen et al., 2023; Horrigan, 2024)

The *digital divide*—the gap between those who reliably access digital technologies and those who cannot—carries important implications for inclusive economic growth as opportunities, services, and resources become increasingly centralized online. The divide is especially pronounced along economic lines: Computer use among households earning more than $100,000 per year is approximately 78 percent compared with 47 percent among households earning less than $20,000 per year—with similar gaps for home internet use. Therefore, the digital divide threatens to exacerbate existing socioeconomic disparities as technology continues to evolve.

Closing the digital divide has long been a federal policy priority, particularly since the coronavirus disease 2019 (COVID-19) pandemic. Figure 1 shows a steady decline in the share of those in the United States who do not connect to the internet: Since 2009, the percentage of households without home internet has dropped by half—from 30 percent to 15 percent. Federal policy efforts have successfully increased internet uptake in three ways: (1) increasing the physical deployment of broadband networks, (2) making the cost of a monthly subscription to broadband internet services more affordable, and (3) increasing access to low-cost computer devices. The impacts of these efforts can be clearly seen in Figure 2, which plots the main reasons that non-internet users remain disconnected. The percentage of users who cite cost as the primary barrier fell from roughly 30 percent to 15 percent since 2009, and those reporting a lack of devices dropped from 20 percent to nearly zero during the same period. Few respondents have cited physical availability as a primary barrier since 2009.

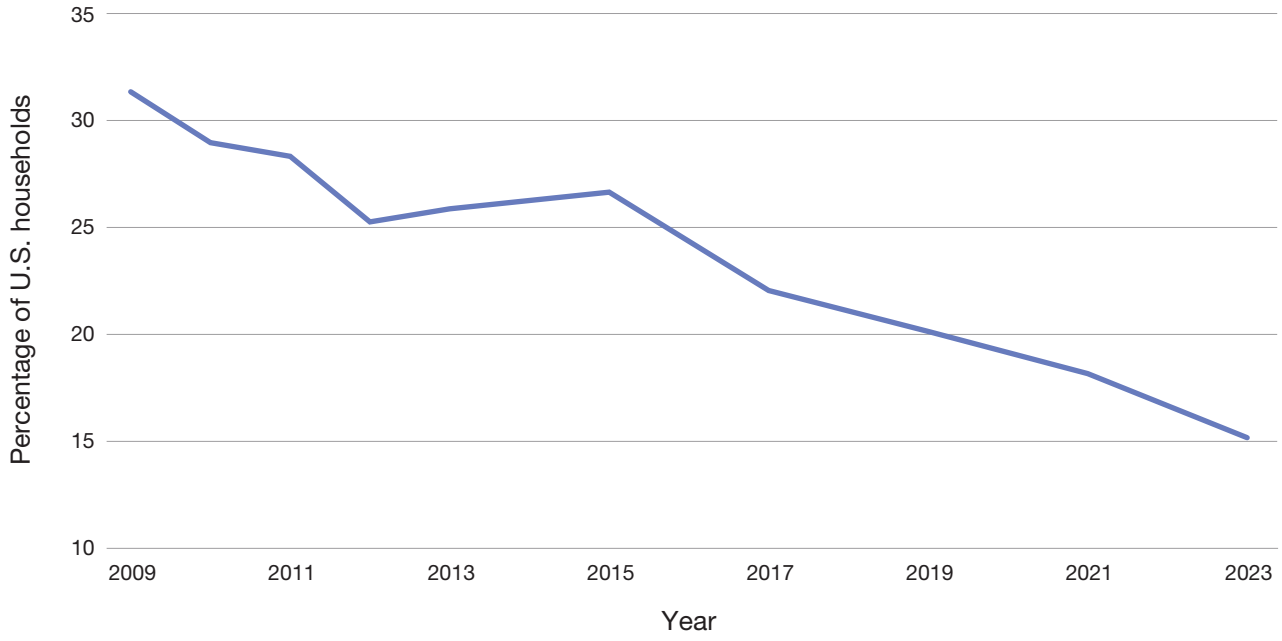
Policymakers have justifiably prioritized expanding digital access by making broadband internet services more affordable and improving infrastructure—these are concrete and straightforward policy solutions for bridging the digital divide. However, affordability and physical proximity to broadband networks now represent the primary barrier for fewer than 20 percent of unconnected households. By contrast, more than half of unconnected households indicate that they have no interest or do not see the need to use the internet at home. Although some households have intentionally decided to remain offline, many households likely underestimate the benefits of internet access, or they lack the skills and

Abbreviations

CF1	Computer Foundations 1
CPS	Current Population Survey
DOES	Department of Employment Services
IT	information technology
NTIA	National Telecommunications and Information Administration
SNAP	Supplemental Nutrition Assistance Program
SSI	Supplemental Security Income

FIGURE 1

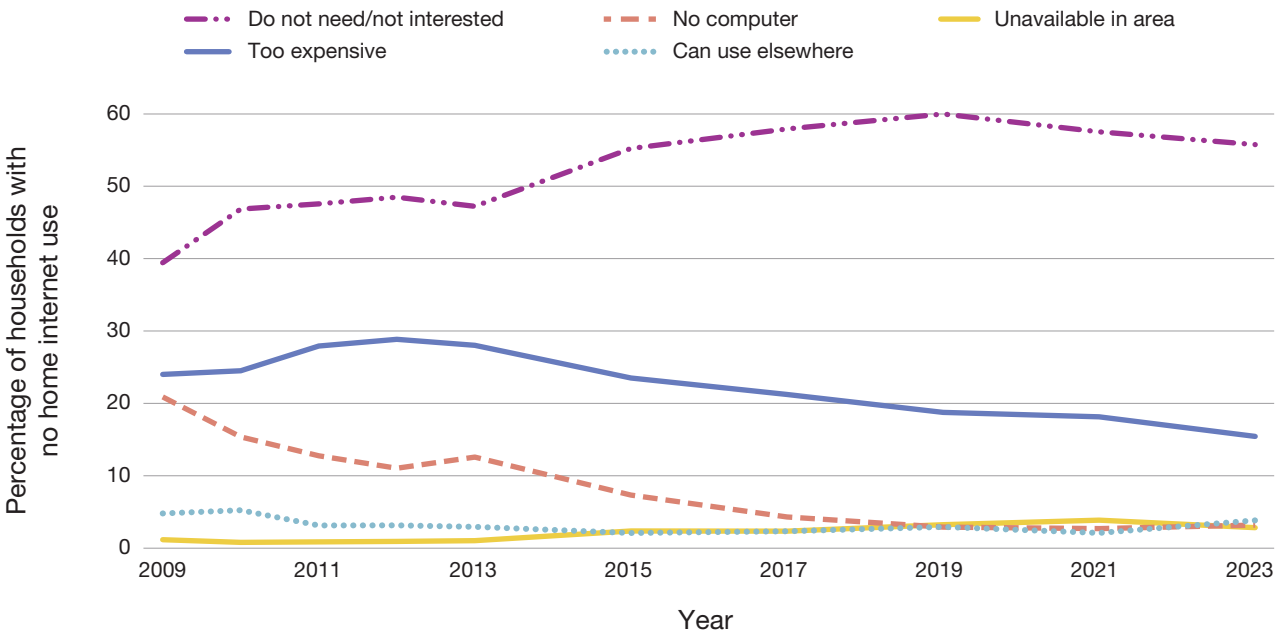
Percentage of U.S. Households Without the Internet at Home



SOURCE: This figure presents data from the CPS Computer and Internet Use Supplement, accessed through the NTIA data portal (NTIA, 2024).
NOTE: The Computer and Internet Use Supplement asks respondents whether anyone in the household uses the internet.

FIGURE 2

Primary Reason Why Households Do Not Use Home Internet



SOURCE: Features data from the CPS Computer and Internet Use Supplement, accessed through the NTIA data portal (NTIA, 2024).
NOTE: The Computer and Internet Use Supplement asks respondents who do not have home internet for the primary reason why. We plotted the responses using data from every iteration of the Computer and Internet Use Supplement, which is administered roughly every other year, starting from 2009.

In this report, we examine how the training of foundational digital skills translates to changes in digital proficiency.

confidence needed to connect online and access digital tools, services, and resources.

Although it is difficult to ascertain exactly how much the digital divide would close if digital skill gaps were eliminated, estimates from the early 2010s suggest that nearly one-third of U.S. workers lacked foundational digital skills. This group was disproportionately composed of low-income and low-education people of color (i.e., individuals whose highest educational attainment was a high school diploma) (Bergson-Shilcock, 2020). The number of individuals who are unconnected because of a lack of basic digital literacy is therefore potentially quite high.

For the labor market in particular, digital skills and technologies are becoming increasingly important: 92 percent of all job ads, including ads for many entry-level roles and jobs requiring only a high school diploma, currently require "definitely digital" or "likely digital" skills, (Bergson-Shilcock, Taylor, and Hodge, 2023). Estimates suggest that, by 2045, nearly three-quarters of Black workers will be underqualified for nearly 90 percent of jobs (Walia and Ravindran, 2020). Demand for digital skills spans every industry and firm size—not just tech or white-collar fields—and includes foundational and industry-specific skills. Bridging the digital-skills divide could therefore yield broad economic benefits. At the individual level, workers in roles requiring just one digital skill earn 23 percent more on average than their peers in non-digital roles, which translates to more than $8,000 in additional annual income (Bergson-Shilcock, Taylor, and Hodge, 2023). At the firm level, an increase in skilled workers could potentially increase productivity and reduce employee turnover. Governments at every level (e.g., municipal, state, federal) also potentially benefit from tax revenues generated from these employment gains.

In this report, we examine how the training of foundational digital skills translates to changes in digital proficiency. We conducted a pilot study in conjunction with Byte Back, a nonprofit providing free digital literacy training courses in the Washington, D.C., and Baltimore, Maryland areas. We surveyed participants before and after taking Byte Back's course on foundational digital skills, which encompassed 24 hours of instruction. The study followed students enrolled in courses from January 2023 through June 2024, at which point Byte Back announced that it would be closing its doors permanently.

We report on changes in students' comfort in using computers and their digital proficiency. We also report on changes in labor market outcomes. Although our results should not be interpreted as causal, we provide several data points that provide descriptive evidence showing that changes in the enrollees' outcomes were plausibly a result of their experiences with Byte Back.

This report's focus on foundational digital skills complements a large and growing literature base that focuses on more-advanced digital upskilling in the form of information technology (IT) postsecondary certification-based or credential-based programs (Katz et al., 2022; Schaberg and Ibok, 2022; Greenberg and Schaberg, 2020). Although initial results from evaluations of such programs have uncovered promising results, even the minimum required qualifications to apply for these programs remain far out of reach for individuals who lack foundational digital skills. Furthermore, very little is known about the extent to which these foundational skills affect employment outcomes. Although prior research has documented the theoretical importance of foundational digital skills in the labor force (Hecker and Loprest, 2019) and the growing pervasiveness of job postings requiring basic digital skills (Bergson-Shilcock, Taylor, and Hodge, 2023), we are not currently aware of any evaluation efforts to measure the

labor market impacts of training individuals in foundational digital skills.

Our report's findings have important implications for broad-based economic growth and federal, state, and local investment decisions. Although investments in digital-skills training have historically been underrepresented in the digital divide policy space, many experts anticipate that the Digital Equity Act of 2021 (U.S. Code, Title 47, Subchapter II), a $2.75 billion initiative enacted as part of the Infrastructure Investment and Jobs Act (Pub. L. 117-58, 2021), will create new opportunities to address this policy gap. Two key features of the Digital Equity Act, the State Digital Equity Capacity Grant Program (a $1.44 billion program) and the Digital Equity Competitive Grant Program (a $1.25 billion program) both provide potential funding for digital upskilling.[1] The former program supports states in implementing state-specific digital equity plans that could include digital literacy training and skill-building initiatives. The latter program provides support to entities—such as community organizations, libraries, nonprofits, and educational institutions—that could include organizations focusing on delivering digital-skills training. However, these programs allow for a large amount of discretion, and it is unclear what proportion of funds will ultimately flow into digital-skills training—and if funds become available, the extent to which foundational digital skills will be prioritized (relative to more-advanced training) is also unclear. It is therefore crucial that we better measure the potential benefits that foundational digital-skills training programs can provide.

Byte Back and Computer Foundations 1

Byte Back was a nonprofit 501(c)(3) providing digital literacy training and computer certification courses from 1997 until 2024 in Washington, D.C., and Baltimore, Maryland. Byte Back primarily served adults from historically excluded and underresourced communities: At intake, 96 percent of enrollees were people of color, 87 percent were unemployed, and 72 percent received government benefits. The program's motto, "Tech within Reach," underscored its mission to help members of underserved communities overcome non-financial barriers that prevent them from adopting technology in their lives, opening doors to living-wage careers in the modern digital economy.

Byte Back's core course offering, Computer Foundations 1 (CF1), was the starting point for adults with little to no computer experience. CF1 was provided free of charge to all students. The course introduced students to foundational digital skills, such as using a mouse, typing with a keyboard, storing and managing files, writing and sending emails, using search engines, videoconferencing, and completing basic tasks in Microsoft Word. Students also learned privacy and security best practices and steps for purchasing their own computer. Instruction relied heavily on hands-on learning labs with a focus on job readiness. Byte Back provided students with a laptop computer, an internet hotspot for home use, and in-person support via office hours and tutoring.

The standard CF1 offering was a month-long course providing 24 total hours of instruction delivered through two-hour class sessions occurring three days a week. However, roughly two-thirds of students enrolled in CF1 after being referred by the Department of Employment Services (DOES) in Washington, D.C. Each month, Byte Back offered a condensed week-long course (five hours per day) specifically for these students. Course content was identical across both tracks. Byte Back also offered industry-recognized certification training for more-advanced students; however, this report focuses on measuring the impacts of CF1.

Table 1 describes the CF1 students during the study period. Our study included the 280 students who participated in CF1 classes spanning from January 2023 through May 2024. CF1 students came primarily from economically disadvantaged backgrounds and were adult learners from racial-minority backgrounds; nearly 90 percent identified as Black and about 6 percent as Hispanic. Students were predominantly female, with males making up only 39 percent of enrollees. The average student age was approximately 41 years old; the largest proportion of students were between the ages of 25 and 34 (although all adult age groups, including older adults, were represented). Educational attainment among

TABLE 1

Characteristics of Byte Back Students

Characteristic	Mean	Standard Deviation
Race/sex		
Male	0.391	0.489
Black	0.893	0.310
Hispanic	0.056	0.231
Economic		
Employed	0.131	0.338
Annual household income	$8,027	$14,092
Seeking a job	0.859	0.348
Precariously housed	0.283	0.451
Any benefit programs	0.721	0.450
SNAP	0.537	0.500
Medicaid	0.066	0.249
SSDI	0.121	0.327
SSI	0.368	0.483
Retirement	0.015	0.121
Age		
Average age (years)	40.7	15.0
18–24	0.107	0.310
25–34	0.357	0.480
35–44	0.150	0.358
45–54	0.175	0.381
55–64	0.146	0.354
65+	0.064	0.246
Digital		
Computer at home	0.551	0.498
Broadband at home	0.638	0.482
Ever used a computer	0.924	0.266
Ever used the internet	0.826	0.380
Education		
Elementary/middle	0.015	0.121
High school	0.619	0.487
Vocation/trade school	0.104	0.305
College	0.263	0.441
Course information		
Washington, D.C., student	0.886	0.319
Took both surveys	0.493	0.501
Passed the class	0.743	0.438
Did not pass the class	0.136	0.343
Dropped the class	0.093	0.291
Other characteristics		
Single parent	0.330	0.471
Has disability	0.210	0.408
Veteran	0.029	0.169

SOURCE: Features data from enrollment records provided by Byte Back, 2023–2024.

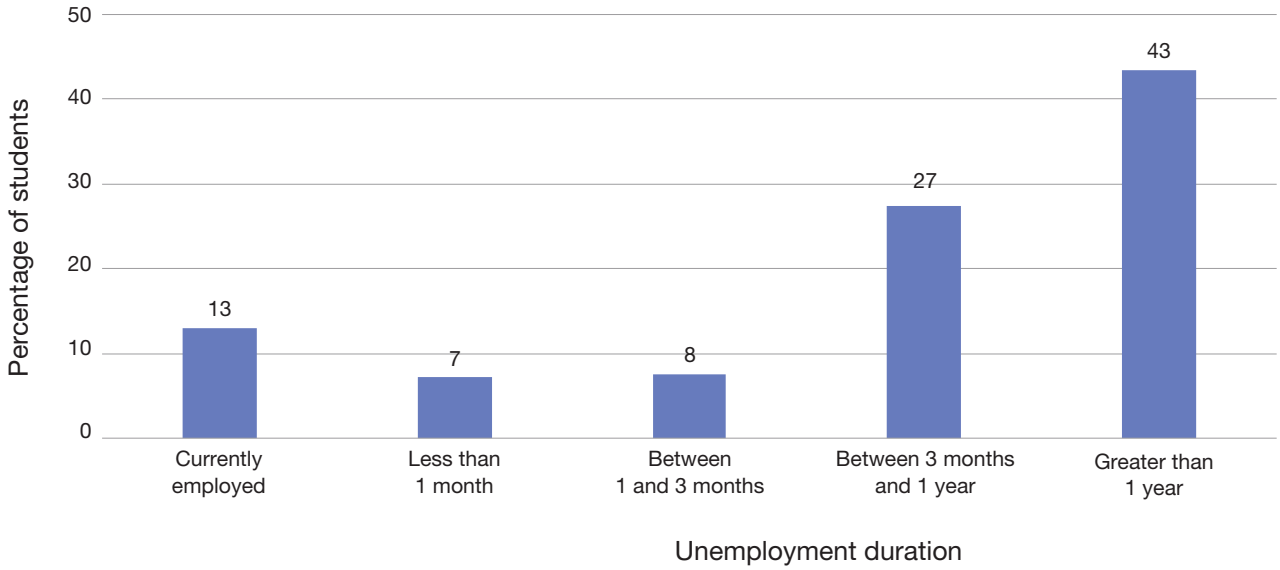
NOTE: The table data are means and standard deviations for Byte Back students' characteristics. Data from enrollment records are all self-reported by students during their intake process and were not independently verified by Byte Back. *N* = 280 respondents. SNAP = Supplemental Nutrition Assistance Program; SSDI = Social Security Disability Insurance; SSI = Supplemental Security Income.

the group was generally low, with more than 60 percent having only a high school diploma and roughly one-quarter having attended college. In terms of digital access, although more than 90 percent of students reported prior computer use and 83 percent had accessed the internet, home broadband services enrollment and personal computer ownership were substantially lower at around 64 percent and 55 percent, respectively.

Economically, the students faced substantial challenges: 13 percent were employed, nearly 86 percent were actively seeking work, and average household incomes were very low, around $8,000 annually.[2] Consequently, enrollees relied significantly on public assistance programs—more than 70 percent received some form of benefit, such as SNAP or SSI benefits. Housing instability affected more than a quarter of students, and approximately one-third were single parents, which further complicated their socioeconomic circumstances. The class also served a significant number of individuals with disabilities (21 percent), although veterans comprised a smaller fraction (less than 3 percent).

FIGURE 3

Distribution of Unemployment Duration Among Byte Back Students



SOURCE: Features data provided by Byte Back, 2023–2024.

NOTE: This figure presents the distribution of Byte Back students' unemployment duration at the start of their enrollment in CF1. All data were self-reported by participants. This figure includes all participants who completed a pre-course survey and did not leave this question blank. *N* = 237 respondents.

To more closely characterize the student population's economic situations, Figure 3 plots the distribution of unemployment duration among students using pre-course survey data. Again, 13 percent were employed at the beginning of the study. Roughly 15 percent of students had been unemployed for three months or less, 27 percent were unemployed between three months and one year, and 43 percent were unemployed for more than one year. This suggests that the vast majority of Byte Back students faced long-term barriers to finding employment.

Research Design and Survey Content

Data were collected from two sites (Washington, D.C., and Baltimore) from January 2023 through May 2024. Unfortunately, Byte Back's closure in June 2024 necessitated that we halt data collection efforts at that point. Despite the closure, we were able to enroll 280 scholars into our pilot study, 90 percent of whom completed the pre-course survey and 60 percent of whom completed the post-course survey. All participants were presented with a consent form and were informed that they would receive a gift card for completing both surveys. The pre-course survey was given to all students on their first day of class. We targeted the post-course survey to be given roughly one month after students graduated from CF1. However, in practice, we found that many students were difficult to contact after they finished the course. We structured follow-up in three phases: an initial follow-up email, a direct phone call, and then a phone call to a relative or friend on file. In the end, the median follow-up length from the class's end to post-course survey was approximately 63 days.

Our survey instrument covered several key topics. We began by assessing participants' recent computer and internet use, including the frequency and context of their computer use, the types of devices used to access the internet, and their attitudes toward technology. Respondents were typically asked to indicate their level of agreement with various statements related to their comfort and confidence in using computers with a four-point Likert scale (ranging from "Strongly Disagree" to "Strongly Agree"). Additionally, we asked about the frequency with which students engaged in specific digital activities,

Perspectives from a Byte Back Site Visit

Although results in this report are largely quantitative in nature, we also provide a qualitative understanding of the CF1 course and its implementation. In fall 2022, we participated in a CF1 class. Although administrative staff coordinated the visit, neither the instructor nor the students knew we were researchers. This enabled us to ask questions and experience the students' and instructor's true reactions.

The class was organized into the following sections: typing practice, vocabulary, resources/opportunities, using technology, and reviewing/assessing knowledge of concepts taught. The instructor, a Black male estimated to be between 35 and 45 years old, demonstrated cultural responsiveness throughout the session. He notably integrated discussions on code-switching, highlighting the importance of adapting communication styles appropriately in different contexts or, as he described it, "flipping the switch." He further provided guidance on financial literacy, explaining how enhanced digital skills could help students evaluate second-hand computer equipment, thus achieving cost savings—a particularly relevant skill given many students' lower-income status.

Throughout the class, the instructor provided coaching beyond digital upskilling. He provided emotional support that clearly enhanced students' confidence. He often said, "Y'all are good. You must have done this before." Additionally, he encouraged students to use course vocabulary to practice and simulate conversations that could occur during interviews and work. He also empowered students to ask questions. More importantly, he encouraged students to harness their existing knowledge because all students were adult learners with undeniable life experiences. Accordingly, instruction was culturally responsive. For example, when explaining the term *icon*, he asked a native Spanish-speaking student how to say "icon" in Spanish and to share with fellow native Spanish speakers. The instructor clearly aimed to foster community-mindedness and a spirit of teamwork, creating engagement opportunities to empower students and enhance their self-efficacy. Students effectively served as co-instructors when they imparted information that supported fellow students' growth.

The instructor also empowered students by addressing common misconceptions about technological proficiency by stating, "People equate not understanding technology with being stupid. Get that out of your mind. There are different types of intelligence." He reassured students that lacking immediate technical knowledge does not equate to low intelligence. He emphasized that even technology professionals regularly rely on resources, such as Google, and he consistently made it clear that one of his goals was to teach students how to similarly use digital tools to learn on their own in situations in which they do not know the answer. He encouraged risk-taking and experimentation without fear of making mistakes, instilling students with a sense of professional potential and continuous self-development. His emphasis on having a growth mindset and pursuing lifelong learning helped orient students toward upward mobility.

Lastly, he taught students marketing and negotiation strategies. He explained the importance of work experience in securing a desirable salary. Accordingly, he suggested the students might have to accept a volunteer position or lower-paying job that would lead to a higher-paying job. He stated, "What you put on your résumé is more valuable than money." He carefully explained how projects completed for family members can be marketed as work experience. Similarly, he addressed the reality of previous incarceration. For example, he mentioned that if someone washed dishes while incarcerated in Maryland, that person could technically list the State of Maryland as a former employer. He emphasized that non-technological skills coupled with technological skills is a winning combination in the modern workforce.

such as emailing, using social media, shopping or banking online, and searching and/or applying for jobs. Second, the survey explored numerous dimensions of labor market engagement. In addition to employment status (i.e., full-time, part-time, not employed) and wages, we asked about participants' job searches, durations of unemployment, use of digital skills on the job, and confidence and optimism regarding job searches and future career prospects.

Byte Back further provided us with students' enrollment data, allowing us to link survey findings with a variety of student characteristics, includ-

ing demographics, socioeconomic characteristics, employment data, course status, and more. The information from these records was self-reported by participants during the enrollment intake process.

Our analysis primarily involved comparing pre- and post-course survey responses. Because there were students who failed to take either the pre- or the post-course survey, the results we present in this report show differences for individuals who took both surveys. To calculate significance, we simply calculated whether individual-level differences were significantly different from zero. In each of our figures, we designate statistically significant pre-post changes by using asterisks: three asterisks represent significance at the 1-percent level, two asterisks represent significance at the 5-percent level, and one asterisk represents significance at the 10-percent level.

In the appendix, we provide an alternative set of results that includes all responses, regardless of whether the student had completed both the pre-course survey and the post-course survey. To calculate significance for this set of results, we stacked all pre-course survey and post-course survey responses and ran a regression of the outcome of interest on an indicator for whether the response came from a post-course survey. We note in the appendix where our results diverge between these two sets of results.

We note several limitations of our pilot study. First, because our study lacked a control group, we caution against a strict causal interpretation of our findings. Without a comparable group of individuals who did not participate in the program, it remains possible that some improvements in employment or digital proficiency occurred naturally or because of external services that were provided concurrently, such as those from DOES. Because of this limitation, we provide several data points that suggest that at least part of our observed effects are likely because of enrollment in CF1. Additionally, the relatively short follow-up period—approximately two months after students completed the course—limited the analysis to immediate outcomes, leaving longer-term impacts uncertain.

Second, participant attrition presented another notable limitation. Only about 60 percent of initial respondents completed both pre- and post-course surveys, potentially biasing results if those who did not respond differed significantly from those who remained engaged. Finally, the closure of Byte Back in July 2024 curtailed data collection, further constraining our sample size and limiting our ability to analyze subgroup differences comprehensively. Despite these limitations, our results provide valuable descriptive insights into the potential benefits of foundational digital-skills training for disadvantaged populations.

Results

Our first set of results in Figure 4 focuses on computer proficiency and attitudes.[3] We found that students saw their

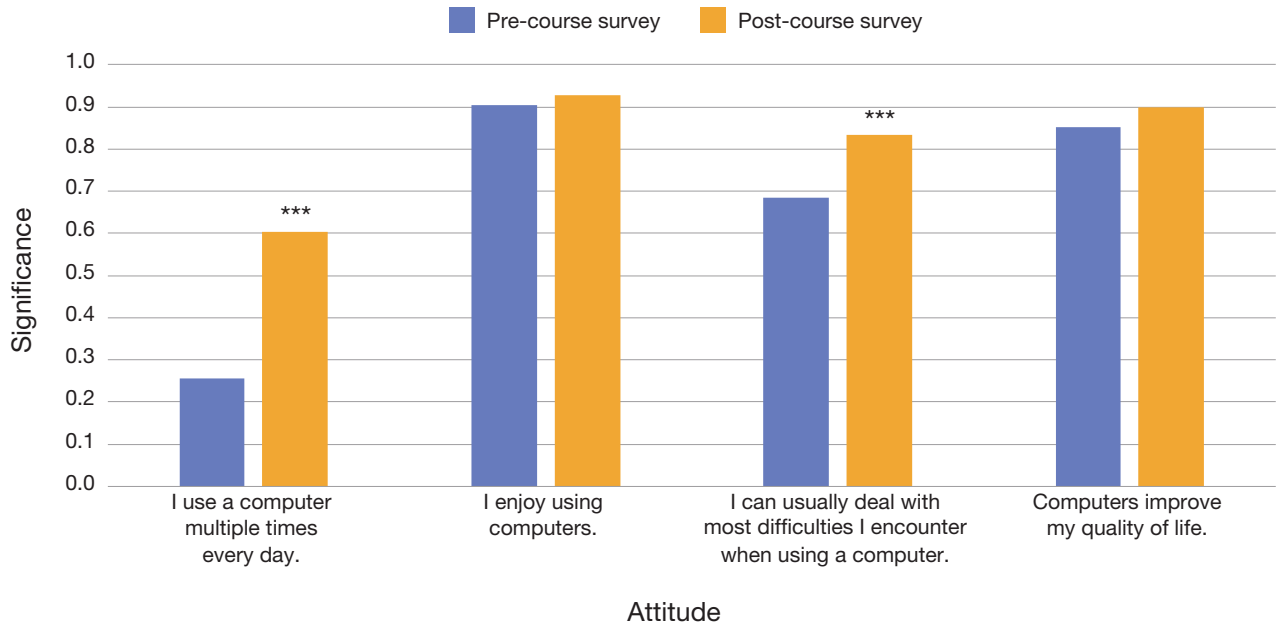
- regular computer use significantly increase (from 34 percent to 62 percent)
- self-perceived abilities to troubleshoot computer issues significantly increase (69 percent to 82 percent)
- attitudes about computers, including enjoyment of using computers and the belief that computers improve quality of life, remain largely unchanged.

One implication of these findings is that, before CF1, enrollees thought highly of computers and their skills with computers. Even among students who indicated that they *never* used computers in their daily lives in their pre-course surveys (17 percent of respondents), more than three-quarters of these respondents indicated in their pre-course surveys that they could usually troubleshoot computer difficulties.[4] More than 90 percent of these respondents also indicated that they enjoyed using computers and that computers improved their quality of life. These results could be consistent with the possibility that most Byte Back students—especially younger students with previous exposure to technology—have *fragmented knowledge* resulting in some familiarity with certain digital tasks (e.g., sending a text message, accessing social media, or starting a video call) but a lack of experience with other tasks (e.g., formatting an email, creating a spreadsheet).

Enrollment in CF1 also dramatically changed how and where enrollees were accessing computers. Figure 5, Panel A presents the distribution of com-

FIGURE 4

Attitudes About Computers



SOURCE: Features student survey responses provided by Byte Back, 2023–2024.

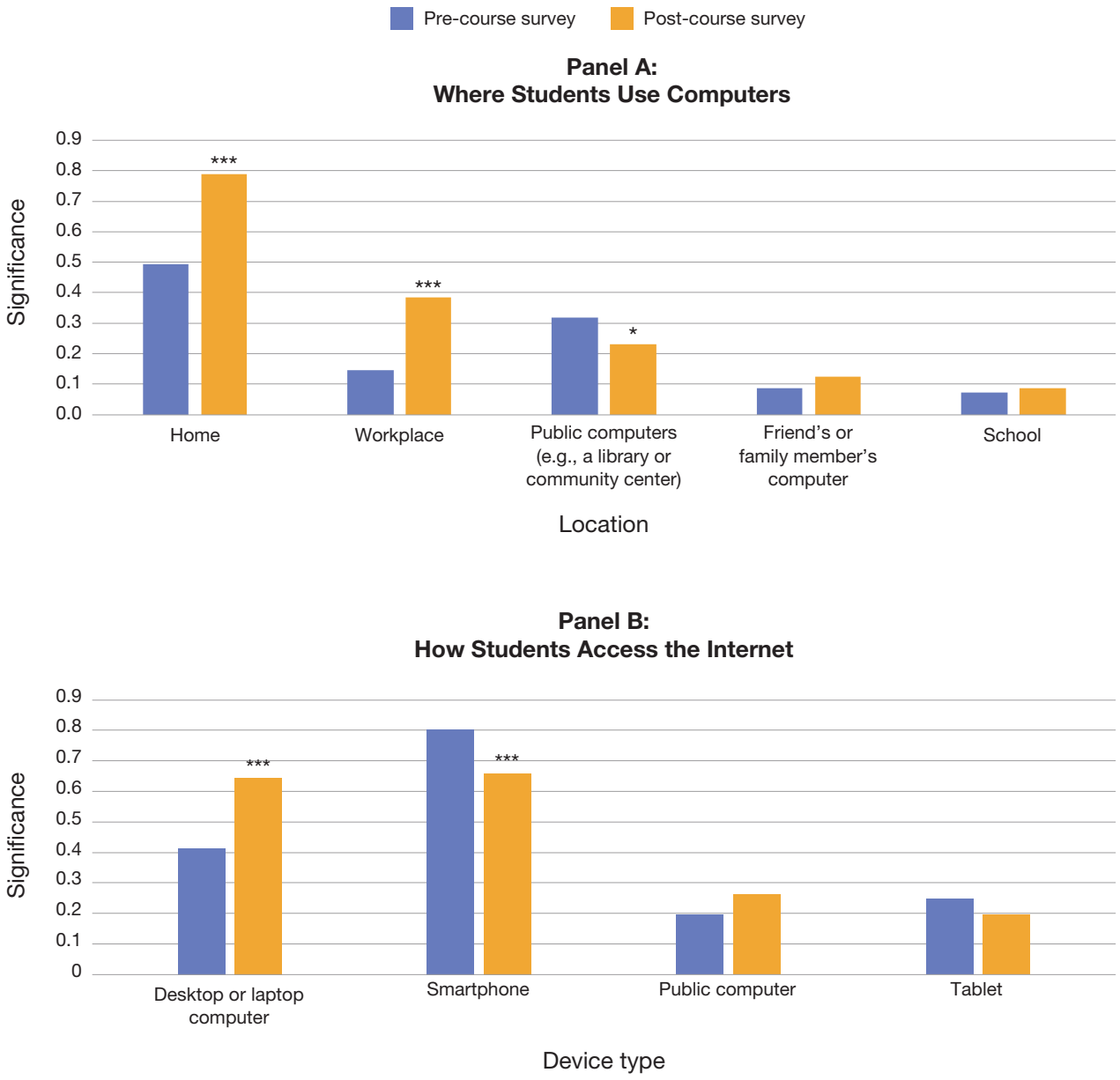
NOTE: This figure compares students' responses from the pre-course survey with responses from the post-course survey (and includes responses only from students who completed both surveys). For computer use, students were presented with the prompt, "How often do you use a laptop or desktop computer?" Responses included "Never," "Once or twice a week," "Once or twice on most days in a week," and "Multiple times every day." For the other three attitudes, respondents were asked to indicate whether they strongly disagreed, disagreed, agreed, or strongly agreed with the statements shown. Results were aggregated by an affirmative response ("Agree" or "Strongly Agree"). N = 138 respondents. *** = $p < 0.01$; ** = $p < 0.05$; * = $p < 0.10$.

puter use, both pre- and post-CF1. Prior to CF1, half of the enrollees used a home computer, and roughly one-third used public computers. Nearly 15 percent of students used a computer at their workplace, and a similar number of students used computers at school. Similarly, about 10 percent of students relied on friends or family for computer access. After participation in CF1, the percentage of students using a home computer increased significantly from 49 percent to 79 percent, and the percentage of students using a computer in the workplace rose significantly from 14 percent to 38 percent. Consequently, reliance on public computers fell from 32 percent to 23 percent, though this decrease was only significant at the 10 percent level. This suggests the possibility that the increase in home and/or workplace computer use might have reduced the need to rely on public computers. The rise in home computer use suggests that CF1 students were likely able to find and purchase affordable personal computers (this is consistent with our notes from our site visit).[5] The rise in workplace computer use suggests that many workers were able to find jobs in which computer use was expected (we present our results on labor market outcomes later in the report).

We also asked students how they accessed the internet. Figure 5, Panel B shows that, prior to enrolling in CF1, most students had experience accessing the internet using their smartphones (80 percent). Forty-one percent of students accessed the internet using home computers, and roughly 20 percent to 25 percent of students were accessing the internet using public computers or tablets. After completing CF1, computer-based internet access increased significantly from 41 percent to 64 percent and was accompanied by a significant decrease in phone-based use, which declined from 80 percent to 66 percent. The change from smartphone-based internet access to computer-based internet access suggests that some students stopped relying on their smartphone to access the internet and instead relied entirely on their computer. Still, this finding was

FIGURE 5

Where Enrollees Use Computers and How They Access the Internet



SOURCE: Features student survey responses provided by Byte Back, 2023–2024.

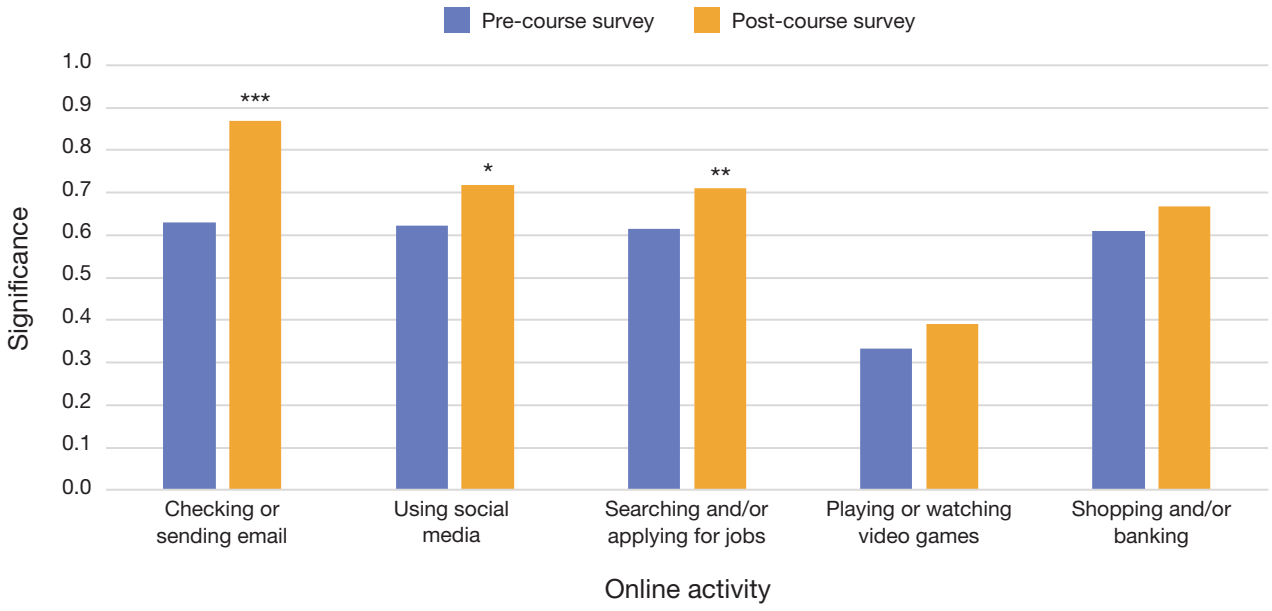
NOTE: This figure compares students' responses from the pre-course survey with students' responses from the post-course survey (and includes responses only from students who completed both surveys). To learn where computers were used, respondents were asked, "Over the past week, where have you used a desktop or laptop computer? Please select all that apply." Respondents were similarly asked how they accessed the internet: "Over the past week, how have you accessed the internet? Please select all that apply." N = 138 respondents. *** = $p < 0.01$; ** = $p < 0.05$; * = $p < 0.10$.

somewhat unexpected because many people view computer use as complementary to smartphone use—not as a replacement.

We also examined how enrollment in CF1 affected the frequency of certain digital tasks, including emailing, using social media, searching and/or applying for jobs, gaming, and shopping or banking online. Figure 6 shows that, prior to enrolling in CF1, roughly 60 percent of enrollees engaged with email, social media, job searches,

FIGURE 6

Engagement with Digital Tasks



SOURCE: Features student survey responses provided by Byte Back, 2023–2024.

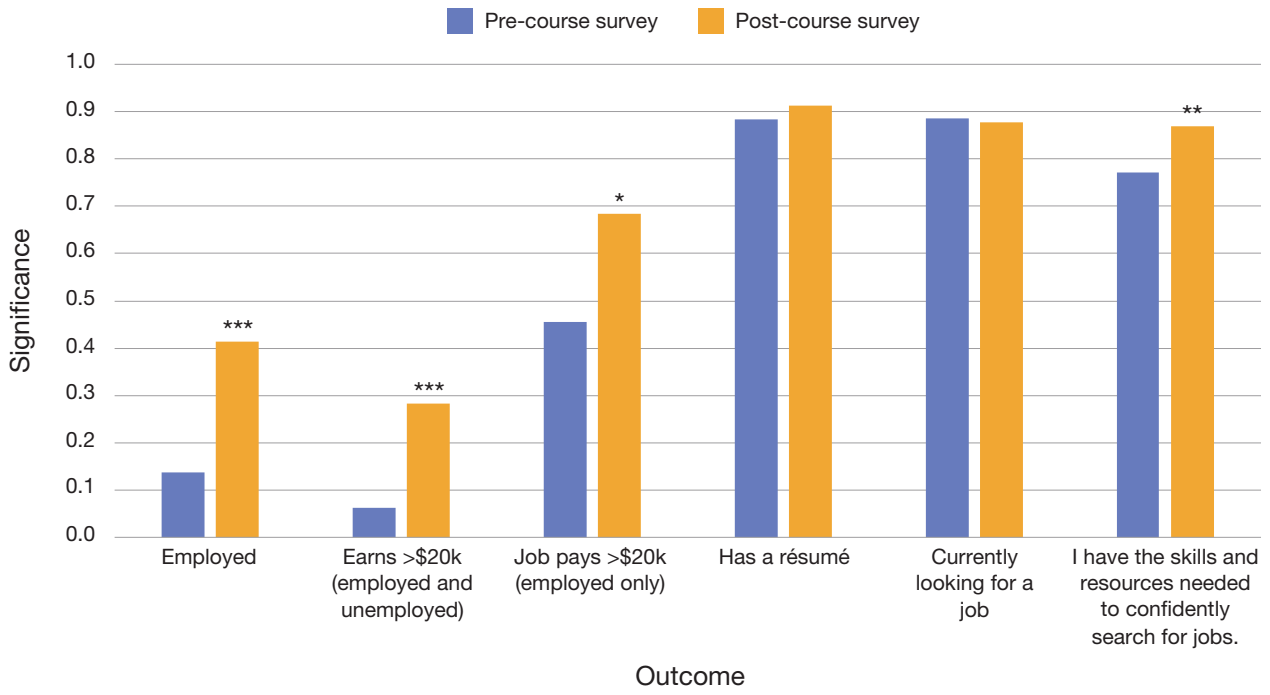
NOTE: This figure compares students' responses from the pre-course survey with responses from the post-course survey (and includes responses only from students who completed both surveys). For each task, respondents were presented with the following choices: "I do this regularly," "I have done this before," and "I have not done this." This figure presents the proportion of respondents who selected the first of these options, indicating regular use. N = 138 respondents. *** = $p < 0.01$; ** = $p < 0.05$; * = $p < 0.10$.

and e-commerce. Roughly 30 percent spent time regularly playing or watching games. Although the percentage of individuals regularly doing each of these tasks increased, we only observed significant increases for email (63 percent to 87 percent) and for job searches (61 percent to 71 percent). These findings suggest that participation in CF1 primarily increased the use of work-related tasks; it did not increase interest or engagement in other daily activities, such as using social media and shopping online. However, in the appendix, Figure A.3, we note that when we relaxed the sample restriction requiring respondents to have completed both surveys, we observed significant increases in both social media use and online shopping and banking.

Last, we examined differences in labor market outcomes before and after participation in CF1. The differences in employment statuses were large and dramatic—only 14 percent of students indicated that they were employed prior to enrolling in CF1, and 41 percent were employed when they took the follow-up survey. Pre-CF1, just 4.5 percent of enrollees earned more than $20,000 in annual income. Even among those who were already employed, less than half earned more than $20,000 at their jobs (the third column in Figure 7). We also found suggestive evidence that scholars ended up in higher-paying jobs after completing the course. Prior to enrolling in CF1, just 45 percent of employed individuals were earning more than $20,000 at their jobs. That number increased to 68 percent after completing CF1, although we caveat that this increase was significant only when the change was at the 10-percent level. Figure 8 provides additional insight into these improvements. Not only did the overall number of wage earners increase drastically, but so did the distribution of wage amounts. Prior to enrolling in CF1, 47 percent of wage earners made less than $20,000 annually; 26 percent made between $20,000 and $40,000; and 15 percent made between $40,000 and $60,000. After completing CF1, 30 percent of wage earners made less than $20,000 in a year; 32 percent made between $20,000 and $40,000; and 29 percent made between $40,000 and $60,000. Finally,

FIGURE 7

Labor Market Outcomes



SOURCE: Features student survey responses provided by Byte Back, 2023–2024.

NOTE: This figure compares students' responses from the pre-course survey with responses from the post-course survey (and includes responses only from students who completed both surveys). The second and third columns differ in that the second column captures average earnings, including any $0 or blank answers from unemployed students. The third column captures wage earnings only from employed respondents. More information on wage earnings is provided in Figure 8. The final column shows results from the question that asked participants to respond on a four-point Likert scale; this figure tracks the proportion of students who responded affirmatively ("Agree" or "Strongly Agree"). *N* = 138 respondents. *** = $p < 0.01$; ** = $p < 0.05$; * = $p < 0.10$.

we found that, prior to enrolling in CF1, roughly 90 percent of participants already had a résumé—a number that did not change after completing CF1. We also found a slight uptick in job optimism after completing CF1 (from 77 percent to 87 percent). In the appendix, Figure A.4, we note that when relaxing the requirement for inclusion of individuals who completed both surveys, we observe that résumés and job optimism both increase significantly.

We did not find statistically significant differences in effect sizes by gender, education, age, or government assistance. However, we caveat that this could partially be explained by the limited sample size of our study at baseline; splitting the sample into subgroups further limited our ability to detect group-by-group differences. Alternatively, it is possible that different subgroups benefited similarly from CF1.

One particularly interesting result was that even after the uptick in employment, participants continued to be open to looking for new work at very high rates. Prior to CF1, 88 percent of students indicated that they were looking for a job, which includes the 14 percent who were employed at baseline. The number of students looking for a job remained nearly the same, at 87 percent, after completing CF1—even though 40 percent of respondents were employed after completing the course. This suggests that even though many students ultimately found jobs, the vast majority of individuals did not feel as if their jobs at the time was the best employment opportunity they could find.

We discourage readers from ascribing a causal interpretation to these results because of our lack of a control group. One reason we are not sure of Byte Back's effects is the possibility that participants would have found employment opportunities organically over time, independent of their progress in the Byte Back course. The average amount of time that

FIGURE 8

Distribution of Wage Earnings Among Employed Participants

SOURCE: Features student survey responses provided by Byte Back, 2023–2024.

NOTE: This figure compares students' information on wage earnings from pre-course surveys and students' wage earnings from post-course surveys and includes responses only from (1) students who completed both surveys, (2) students who were employed when they took each survey, and (3) students who provided us with information on their incomes. Individuals were asked to select one of the five options shown in the figure. Pre-course survey *N* = 34. Post-course survey *N* = 69.

elapsed between pre-course surveys and post-course surveys was 63 days. Another reason is that students in the Washington, D.C., site were referred from the city's DOES and were potentially receiving other services concurrently during their involvement with Byte Back. We cannot definitively rule out the possibility that the observed employment gains were because of either of these outside factors.

But we have reason to conclude that participation in Byte Back's course explains at least part, if not all, of the changes that we found. First, among those who were unemployed at enrollment, roughly 70 percent had been unemployed for three months or more. A large body of evidence indicates that individuals with long unemployment spells face disproportionately uphill battles with respect to finding work (Kroft, Lange, and Notowidigdo, 2013; Kospentaris, 2021; Abraham et al., 2019). This suggests that, left untreated, many of these students were unlikely to naturally find employment opportunities during the post-course survey follow-up time frame.

Second, even though students were simultaneously receiving support from DOES, we present three auxiliary findings suggesting that DOES services likely do not account for the entirety of the observed effect in Figure 7.

- First, the city government of Washington, D.C., uncovered a large budget shortfall in 2023 that severely affected DOES in fiscal year (FY) 2024, beginning in October 2023. We found modest and insignificant differences between employment outcomes of students who enrolled before and after FY 2024.
- No students changed employment status between DOES intake and the start of their CF1 class despite many students having week-long or even monthslong waits before ultimately enrolling.
- We found no significant differences between the Washington, D.C., and Baltimore sites despite referrals to the Baltimore site being community-based and not through direct coordination with city employment services.

Discussion and Policy Implications

The findings from this pilot evaluation of Byte Back's CF1 course provide promising evidence that foundational digital upskilling improves labor market engagement and digital proficiency among economically disadvantaged populations. Participants entered the program facing substantial economic challenges, including low average incomes, low employment rates and extended unemployment periods, and heavy reliance on public-assistance programs. They also faced significant barriers related to limited at-home broadband and personal computer access, which exacerbated preexisting economic disparities linked to the multifaceted benefits of using digital tools, resources, and services.

After completing the course, students' average daily computer use doubled, students' perceived computer proficiency rose significantly, and students exhibited considerable improvements in their labor market statuses. Employment rates nearly tripled, suggesting that foundational digital-skills training provided clear initial benefits even without advanced technical certifications. However, despite these gains, most respondents continued to express that they were actively looking for work, underscoring persistent economic vulnerability.

These findings suggest that foundational digital-skills training helps participants initially enter the labor market, but further training or career support might be necessary for sustained career stability and advancement. Still, these outcomes represent a promising start for these students—many of whom faced long-term barriers to finding work when beginning CF1.

Regarding the digital divide, CF1 students became almost 50 percent more likely to access the internet from a home computer and slightly less likely to rely on smartphones to do so. Our findings suggest that even individuals who self-selected into CF1 were unlikely to use a home computer connection to go online: The vast majority used smartphones, and many likely considered that smartphone use was sufficient and that it was unnecessary to take the extra step to pay for broadband services at home. CF1 appeared to not only help students find affordable personal computers to use but also increase their awareness of the benefits of a home internet connection.

Again, given the absence of a rigorous control group, we caution against interpreting our results through a strictly causal lens. Nevertheless, we have highlighted several reasons that we believe Byte Back's course played a significant role in achieving these outcomes. Collectively, these points strongly suggest that Byte Back's culturally responsive, emotionally supportive approach, combined with its practical professional development and digital-skills training, played a crucial role in facilitating observed outcomes.

Our results point to the following implications for policymakers and officials shaping digital-equity and workforce-development policies; workforce-development practitioners and community organizations implementing digital-skills training; and education professionals focused on adult, vocational, and community college curricula:

- **Expand foundational digital literacy initiatives.** States have an unprecedented opportunity to use federal funds to support digital-skills training. An outsized body of evidence on advanced digital upskilling (e.g., IT and cybersecurity certifications) could skew investments toward these programs, and policymakers should not neglect investments in foundational digital-skills training programs because of such programs' potentially outsized benefits in shaping employment outcomes for historically underserved communities. This distinction is important because there is likely little overlap between individuals requiring foundational digital-skills training versus those qualified to undergo more-advanced upskilling and achieve certifications.
- **Integrate employment training with digital-skills training.** Workforce-development programs should consider including digital literacy training to simultaneously address digital barriers and improve labor market outcomes.
- **Provide ongoing career and technical support.** Foundational digital skills alone signifi-

cantly enhance initial employment outcomes, but sustained support through advanced training, mentorship, and continuous professional development could be necessary to achieve long-term job retention and career progression.

- **Increase awareness of how to affordably acquire personal digital resources.** Policymakers and practitioners should aim to increase awareness of how individuals who do not or cannot connect to the internet can affordably purchase personal computers and reliable broadband services, which could increase digital interest and engagement and lead to improved access to tools, services, and resources to improve the job-search process.
- **Tailor programs to community and cultural contexts.** Digital literacy initiatives should aim to incorporate culturally and contextually relevant practices that leverage participants' existing skills and experiences.

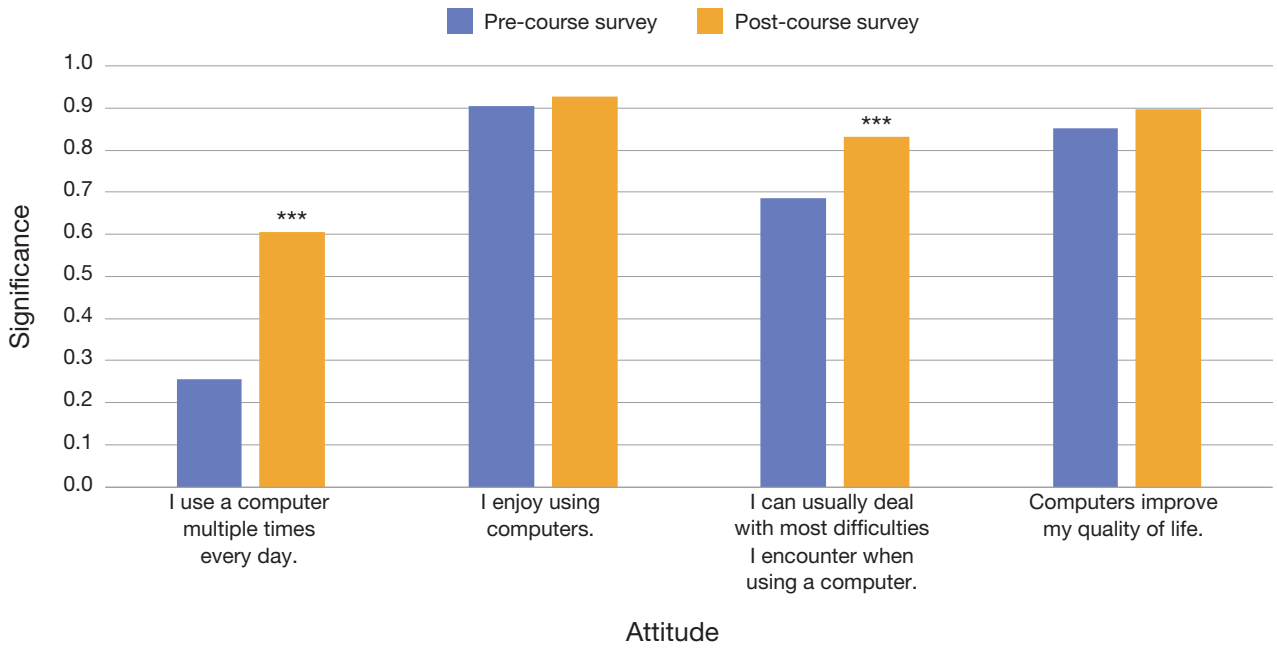
APPENDIX

Alternative Graphs

In this appendix, we present alternative versions of the survey results using the entire population of students who participated in our pilot study regardless of whether they had completed both surveys (Figures A.1–A.4). To calculate whether the pre- to post-course survey change was significant, we did not generate individual-level changes in outcomes; rather, we stacked all pre-course survey and post-course survey responses, and we ran a regression of the outcome of interest on an indicator for whether the response came from a post-course survey.

FIGURE A.1

Attitudes About Computers (All Responses)

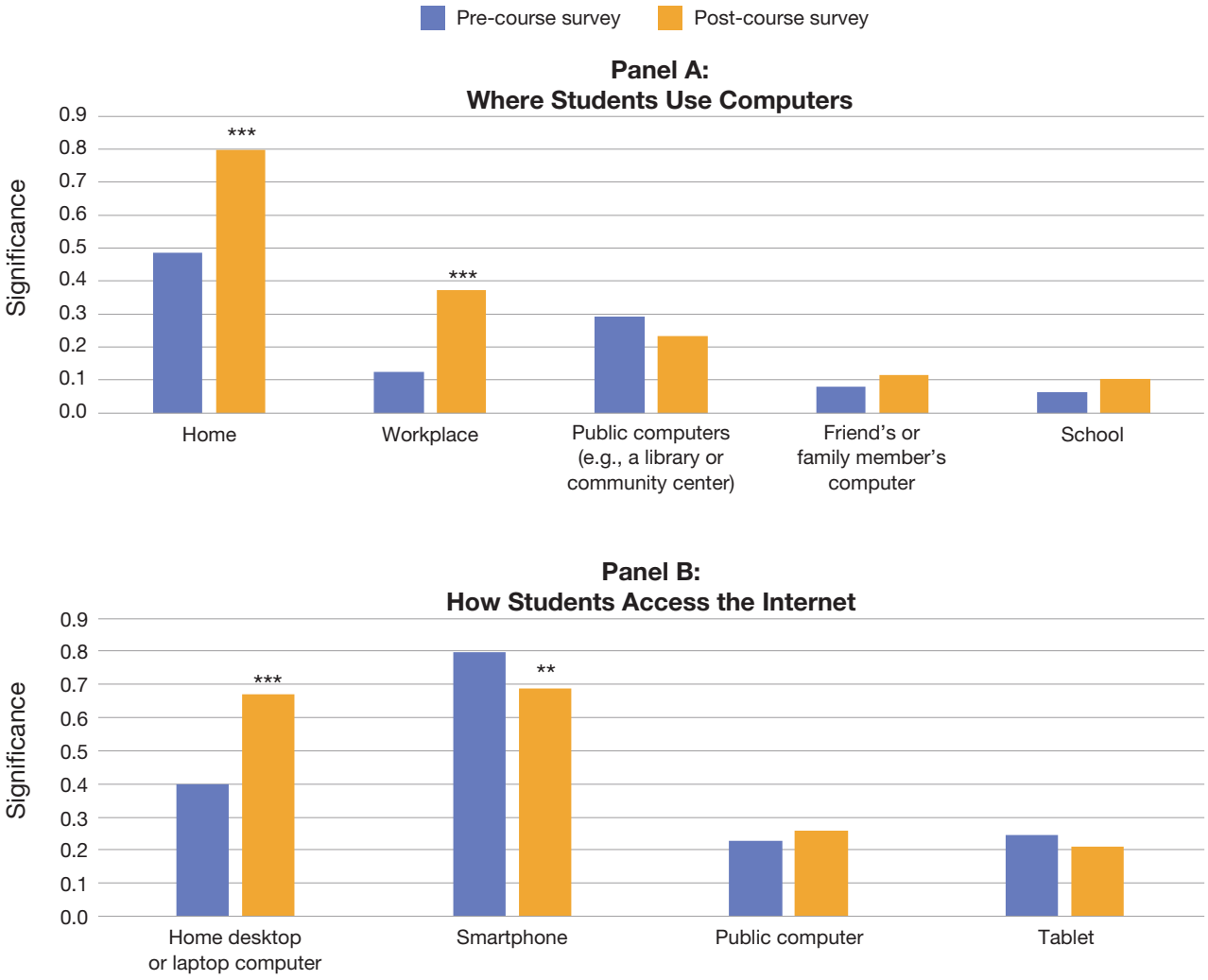


SOURCE: Features student survey responses provided by Byte Back, 2023–2024.

NOTE: This figure compares students' responses from pre-course surveys with students' responses from post-course surveys regardless of whether individuals completed both surveys. To learn of students' computer use, students were presented with the prompt, "How often do you use a laptop or desktop computer?" Responses included "Never," "Once or twice a week," "Once or twice on most days in a week," and "Multiple times every day." For the other three attitudes, respondents were asked to indicate whether they strongly disagreed, disagreed, agreed, or strongly agreed with the statements shown. Results were aggregated above by an affirmative response ("Agree" or "Strongly Agree"). N = 280 respondents. *** = $p < 0.01$; ** = $p < 0.05$; * = $p < 0.10$.

FIGURE A.2

Where Enrollees Use Computers and How They Access the Internet (All Responses)

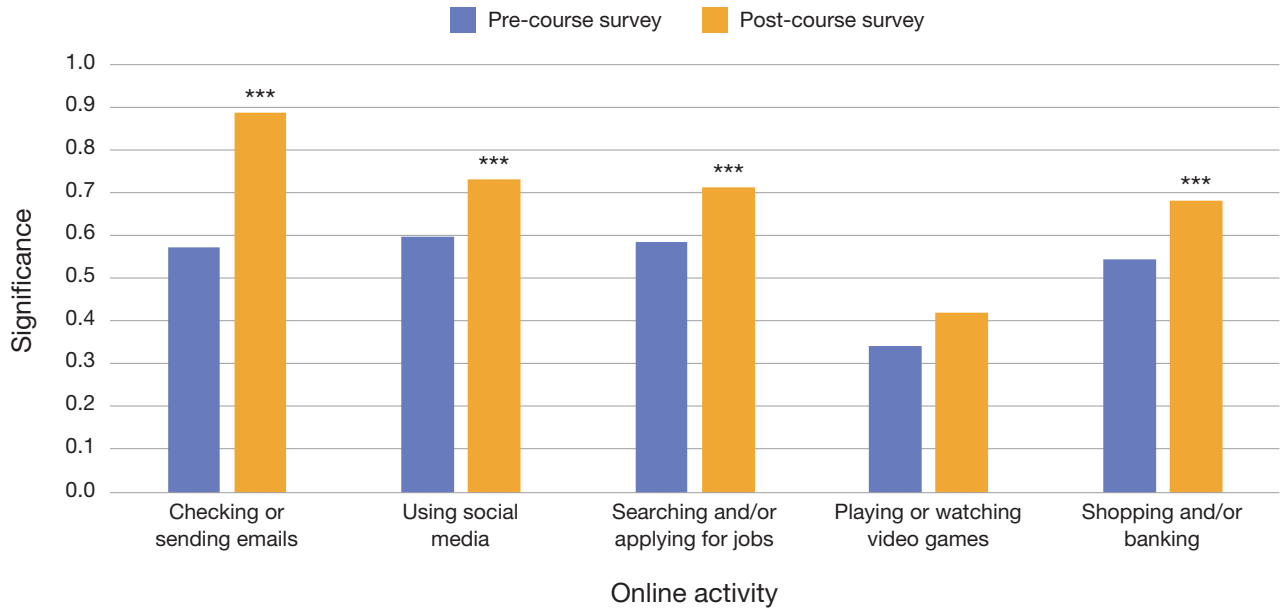


SOURCE: Features student survey responses provided by Byte Back, 2023–2024.

NOTE: This figure compares students' responses from pre-course surveys and students' responses from post-course surveys, regardless of whether individuals completed both surveys. To learn about students' computer use, respondents were asked, "Over the past week, where have you used a desktop or laptop computer? Please select all that apply." Respondents were similarly asked about how they accessed the internet: "Over the past week, how have you accessed the internet? Please select all that apply." $N = 280$ respondents. *** = $p < 0.01$; ** = $p < 0.05$; * = $p < 0.10$.

FIGURE A.3

Engagement with Digital Tasks (All Responses)

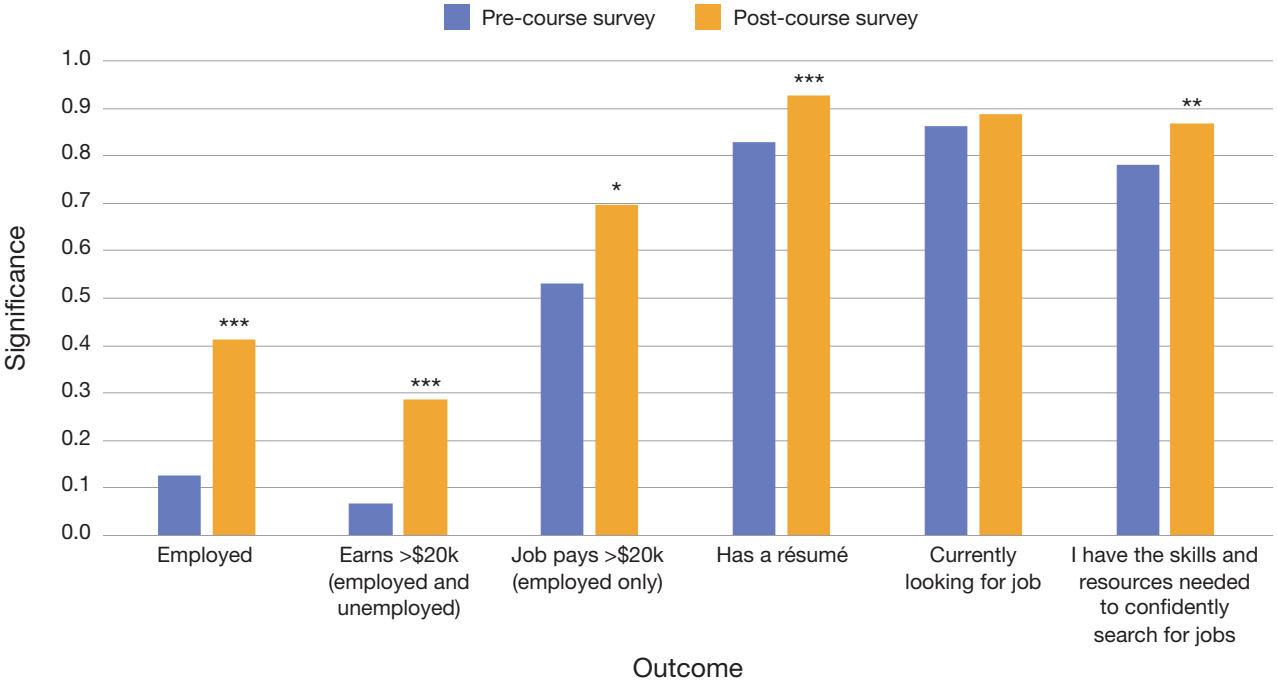


SOURCE: Features student survey responses provided by Byte Back, 2023–2024.

NOTE: This figure compares students' responses from pre-course surveys with students' responses from post-course surveys, regardless of whether individuals completed both surveys. For each task, respondents were presented with the following choices: "I do this regularly," "I have done this before," and "I have not done this." This figure presents the proportion of respondents who selected the first of these options, indicating regular use. N = 280 respondents. *** = $p < 0.01$; ** = $p < 0.05$; * = $p < 0.10$.

FIGURE A.4

Labor market Outcomes (All Responses)



SOURCE: Features student survey responses provided by Byte Back, 2023–2024.

NOTE: This figure compares students' responses from pre-course surveys with students' responses from post-course surveys, regardless of whether individuals completed both surveys. The second and third columns differ in that the second column captures average earnings, including any $0 or blank answers from students without employment. The third column captures only wage earnings from employed respondents. The final column shows results from the question that asked participants to respond on a four-point Likert scale; this figure tracks the proportion of students who responded affirmatively ("Agree" or "Strongly Agree"). N = 280 respondents. *** = $p < 0.01$; ** = $p < 0.05$; * = $p < 0.10$.

Notes

[1] We caveat that it is unclear whether and when these funds will actually be disbursed under the current administration (as of this writing).

[2] This average was primarily driven by students who were unemployed and who reported $0 or blank as their annual incomes. Among those who were employed, the mean household income was $21,558.

[3] For questions with Likert-scale responses, we dichotomize these responses by those who answered affirmatively ("Agree" or "Strongly Agree") versus those who did not ("Disagree" or "Strongly Disagree").

[4] This amount is based on our own calculations and is not shown in Figure 1.

[5] Students were provided with a loaner laptop during their enrollment in CF1; however, they were required to return these devices after course completion.

References

Abraham, Katharine G., John Haltiwanger, Kristin Sandusky, and James R. Spletzer, "The Consequences of Long-Term Unemployment: Evidence from Linked Survey and Administrative Data," *ILR Review*, Vol. 72, No. 2, March 2019.

Bacher-Hicks, Andrew, Joshua Goodman, and Christine Mulhern, "Inequality in Household Adaptation to Schooling Shocks: Covid-Induced Online Learning Engagement in Real Time," *Journal of Public Economics*, Vol. 193, January 2021.

Bergson-Shilcock, Amanda, *The New Landscape of Digital Literacy: How Workers' Uneven Digital Skills Affect Economic Mobility and Business Competitiveness, and What Policymakers Can Do About It*, National Skills Coalition, May 2020.

Bergson-Shilcock, Amanda, Roderick Taylor, and Nye Hodge, *Closing the Digital Skill Divide: The Payoff for Workers, Business, and the Economy*, National Skills Coalition, February 2023.

Campbell, Richard Cole, "Need for Speed: Fiber and Student Achievement," *Telecommunications Policy*, Vol. 48, No. 6, July 2024.

Dolfen, Paul, Liran Einav, Peter J. Klenow, Benjamin Klopack, Jonathan D. Levin, Larry Levin, and Wayne Best, "Assessing the Gains from E-Commerce," *American Economic Journal: Macroeconomics*, Vol. 15, No. 1, January 2023.

Greenberg, David H, and Kelsey Schaberg, *Long-Term Effects of a Sectorial Advancement Strategy: Costs, Benefits, and Impacts from the WorkAdvance Demonstration*, MDRC, March 2020.

Hecker, Ian, and Pamela Loprest, *Foundational Digital Skills for Career Progress*, Urban Institute, August 2019.

Hjort, Jonas, and Jonas Poulsen, "The Arrival of Fast Internet and Employment in Africa," *American Economic Review*, Vol. 109, No. 3, March 2019.

Horrigan, John B., *Leaving Money on the Table: The ACP's Expiration Means Billions in Lost Savings*, Benton Institute for Broadband and Society, July 2024.

Katz, Lawrence F., Jonathan Roth, Richard Hendra, and Kelsey Schaberg, "Why Do Sectoral Employment Programs Work? Lessons from WorkAdvance," *Journal of Labor Economics*, Vol. 40, No. S1, April 2022.

Kospentaris, Ioannis, "Unobserved Heterogeneity and Skill Loss in a Structural Model of Duration Dependence," *Review of Economic Dynamics*, Vol. 39, January 2021.

Kroft, Kory, Fabian Lange, and Matthew J. Notowidigdo, "Duration Dependence and Labor Market Conditions: Evidence from a Field Experiment," *Quarterly Journal of Economics*, Vol. 128, No. 3, August 2013.

National Telecommunications and Information Administration, "NTIA Data Explorer," database, June 6, 2024. As of April 23, 2025: https://www.ntia.gov/data/explorer#sel=internetUser&disp=map

NTIA—*See* National Telecommunications and Information Administration.

Public Law 117-58, Infrastructure Investment and Jobs Act, November 15, 2021.

Schaberg, Kelsey, and Affiong Ibok, *Career Paths for Entry-Level IT Workers: Findings from the Per Scholas WorkAdvance Program*, MRDC, March 2022.

U.S. Code, Title 47, Chapter 16, Subchapter II, Digital Equity Act of 2021.

Walia, Apjit, and Sai Ravindran, *America's Racial Gap & Big Tech's Closing Window*, Deutsche Bank Research, September 2, 2020.

Zuo, George W., "Wired and Hired: Employment Effects of Subsidized Broadband Internet for Low-Income Americans," *American Economic Journal: Economic Policy*, Vol. 13, No. 3, August 2021.

Zuo, George, and David Powell, *The Impact of Affordable and Accessible Broadband on SSDI and SSI Participation*, Michigan Retirement and Disability Research Center, University of Michigan, September 2023.

About This Report

As digital skills become progressively more essential for workforce participation, addressing foundational digital literacy gaps among disadvantaged workers has become an increasingly pressing issue for achieving economic growth for all. In this report, we summarize a pilot study of a course on foundational computer skills and digital literacy. We ran the pilot with the course's administrator, the nonprofit Byte Back, to understand how training on foundational digital skills can affect employment and digital engagement among low-income adult learners from underserved communities (most of the students had incomes below the federal poverty level). The objectives of writing this report were (1) to assess changes in digital proficiency and labor market outcomes following participation in foundational digital literacy training and (2) to highlight critical implications for policymakers, workforce developers, and educational organizations. The intended audience for this report are policymakers and officials shaping digital equity and workforce development policies, workforce development practitioners and community organizations implementing digital skills training, and education professionals focused on adult, vocational, and community college curricula.

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