The Digital Divide Among College Students:

Lessons Learned From the COVID-19 Emergency Transition

POLICY REPORT
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MIDWESTERN HIGHER EDUCATION COMPACT

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EXECUTIVE SUMMARY

This report examines the meaning and impact of the digital divide — the gap between those who can and cannot access the Internet — on college students during the COVID-19 emergency shift to remote learning. The assessment is based on several national surveys conducted in the spring or summer of 2020, as well as results from a large-scale survey the authors conducted at Indiana University and The Ohio State University during the same time period. Key findings of the report are previewed below.

Prevalence of Inadequate Technology

Approximately 16% - 19% of college students reported technology barriers (inadequate computer hardware or Internet connection) that inhibited participation in online learning. Higher rates of technology inadequacy were observed among lower-income students (20%-30%) than higher-income students (10%-12%); Black (17%-29%) and Hispanic (23%-28%) students relative to White students (12%-17%); and students living in a rural area (14%-25%) compared to those living in a suburban (16%) or urban area (16%-20%).

Inadequate Technology and Student Success

Compared to students with robust Internet access and reliable devices, college students with inadequate technology struggled more with the transition to remote learning. For example, they reported a sharper increase in difficulty meeting deadlines and a steeper decline in their sense of success as college students. In addition, regardless of their academic or demographic background, students with inadequate technology were substantially more likely to opt for a "Pass / No-Pass" grade in spring 2020, which signaled that students were struggling with their online coursework.

Institutional and State Approaches

In order to support students with inadequate technology during the emergency transition, most colleges across the U.S. loaned laptops or hotspots to students who needed them or negotiated with vendors to provide free or discounted equipment. At the same time, states leveraged recent legislation or passed new legislation to help bridge the digital divide, particularly in terms of broadband access. Four types of recent broadband policy are evident in the Midwest: streamlining bureaucratic and regulatory models, supporting community and private sector engagement and training, leveraging state resources, and making other financial investments in broadband access.

POLICY OPTIONS

- Support community and private sector engagement and training, by bolstering the efforts of Community Anchor Institutions and creating broadband certifications and trainings for communities.
- Leverage state administration to strategically allocate indirect federal funding to support technology access and to streamline, coordinate, and support the administration of broadband programs through a centralized state office.
- Invest directly in broadband through programs that incentivize or match private and local investment.
- In broadband expansion efforts, place a particular emphasis on wireless broadband in order to maximize access for students who rely on portable wireless devices.
- Incentivize or support colleges in efforts to provide tablets, laptops, and wireless access to students who would otherwise have inadequate technology.

The Digital Divide Among College Students: Lessons Learned From the COVID-19 Emergency Transition

During spring 2020, the entirety of U.S. higher education moved online in response to the COVID-19 pandemic. Very quickly, colleges learned that the "digital divide" is a real challenge for their students. The digital divide refers to the gap between those who can readily access and use the Internet versus those who cannot. In particular, about 27% of U.S. adults do not have broadband Internet at home and thus may find it difficult to conduct critical activities online, such as shopping, seeking employment, or doing academic work (Pew Research Center, 2019). College students might be assumed to be on the "good side" of the digital divide and to enjoy seamless technology access; however, the emergency transition to online learning quickly called that assumption into question.

This report first provides background on the extent of the digital divide within the U.S. in general, and within American colleges and universities in specific, prior to the emergency shift to online learning in spring 2020. To understand the meaning and impact of the digital divide on college students during the emergency shift, results are presented from several national surveys conducted in the spring or summer of 2020, as well as a large-scale survey at Indiana University and The Ohio State University. Using these national and Midwestern-specific data, digital inequities are linked with college students' academic experiences and outcomes during the COVID-19 period. Finally, an analysis of recent state legislation in the Midwest highlights key policy approaches to bridge the digital divide for college students and their communities.

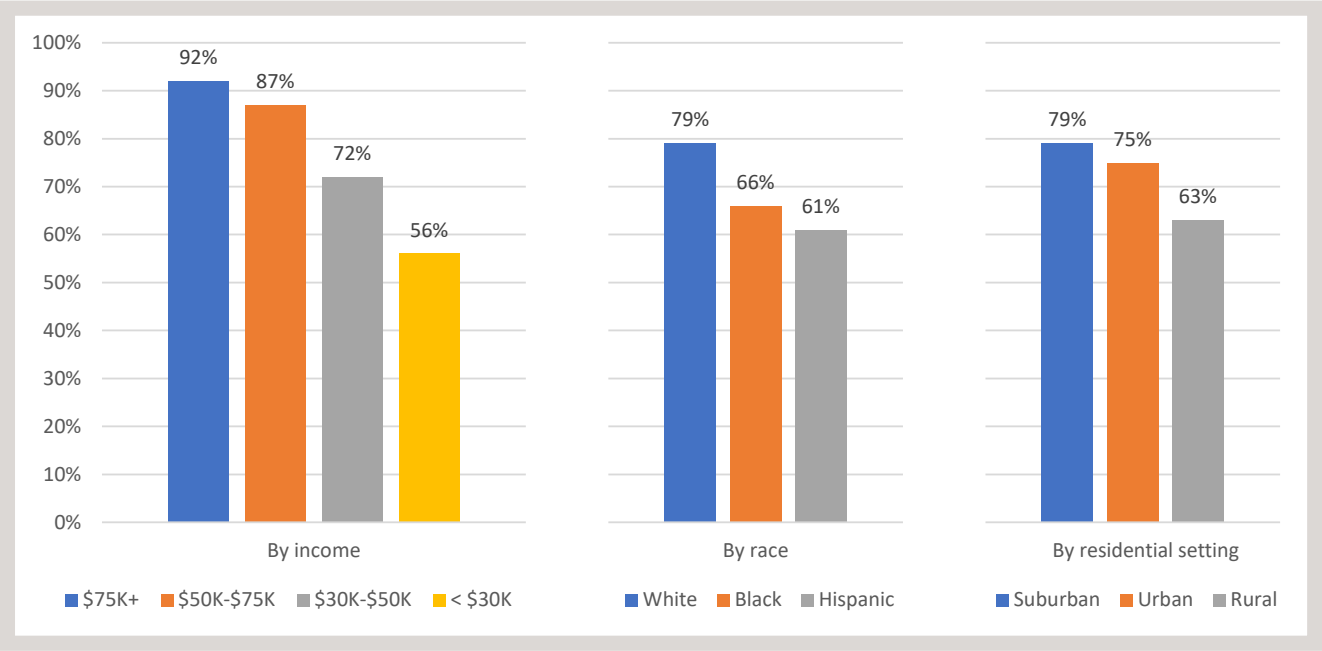
BACKGROUND ON THE U.S. DIGITAL DIVIDE

The digital divide is defined as the "gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard to both their opportunities to access information and communication technologies (ICTs) and to their use of the Internet for a wide variety of activities" (OECD, 2006). An important indicator of the digital divide is the extent to which individuals from different income, racial/ethnic, and geographical groups lack broadband internet at home. The higher speeds of a broadband connection do not just provide greater convenience and efficiency relative to a dial-up connection; many data-intensive applications require broadband capability to function properly, such as videoconferencing and live streaming. Nationally, survey data collected in 2019 indicates that 27 percent of adults lack a broadband connection at home (Pew Research Center, 2019). Moreover, as Figure 1 illustrates, low-income, underrepresented minority, and rural populations in the United States are most likely to lack at-home broadband Internet. For example, only 63% of rural residents have broadband, in comparison to 79% of suburban residents.

In order to use the Internet effectively, individuals need not only robust Internet access but also devices which can connect to the Internet and efficiently manage the task at hand (Fernandez et al., 2019; OECD, 2006). However, 17% of U.S. adults are "cellphone dependent": they rely on a mobile phone for activities such as shopping, finding health information, seeking employment, or doing academic work. Users may turn to cellular data when they lack reliable high-speed Internet or do not have a reliable larger-format device such as a tablet, laptop, or desktop computer (Fernandez et al., 2019; Perrin, 2019; Perrin & Turner, 2019). As Figure 2 shows, cellphone dependency levels are highest among low-income, Black or Hispanic, and rural populations. While smartphones are helpful with basic online tasks, they are inadequate for complex tasks such as completing homework (Fernandez et al., 2019). For example, in a large-scale study of 8th to 11th graders in Michigan, cellphone dependency substantially hindered students' academic progress and success (Hampton et al., 2020).[1]

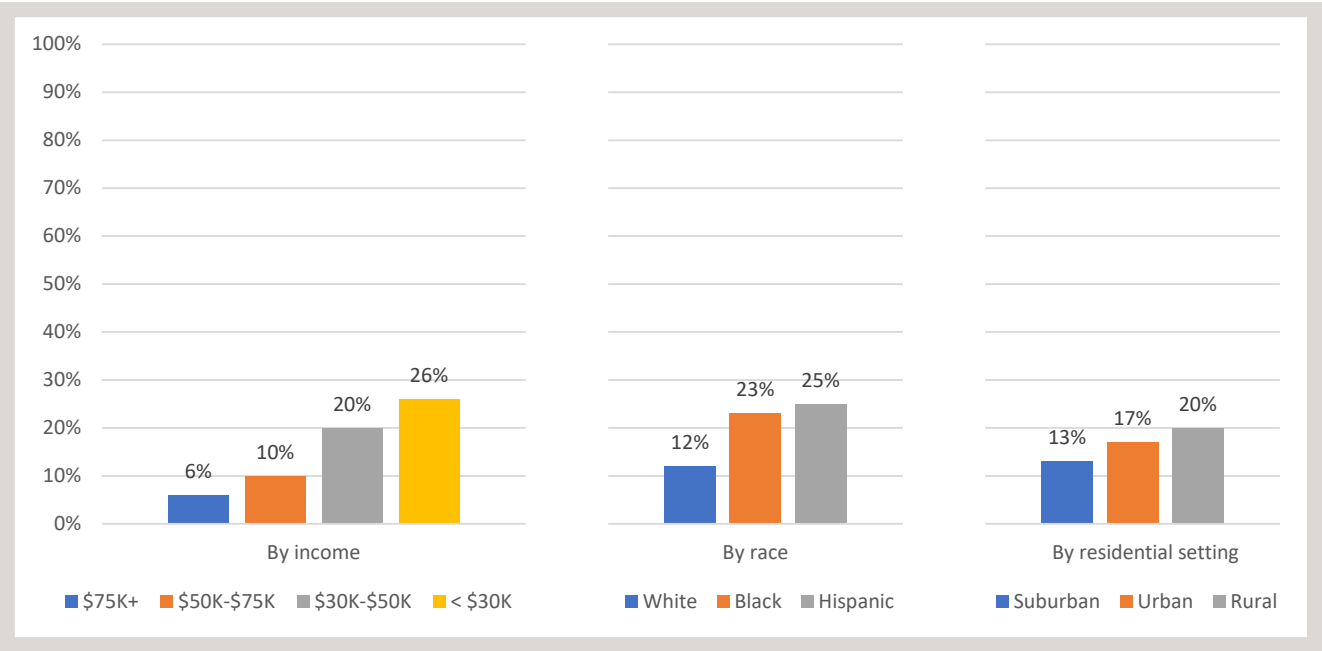
When a cellphone is insufficient, users without at-home Internet turn to the homes of friends and family, coffee shops and restaurants, libraries, and community centers (Perrin & Turner, 2019). However, in communities without widespread broadband infrastructure, public and private alternatives to at-home access are scarce (Hampton et al., 2020).[2] Rural residents may be most likely to suffer from a convergence of limited at-home broadband, spotty cell phone coverage, and lack of nearby alternative access locations. Indeed, 24% of rural adults say access to high-speed Internet is a "major problem" in their local community, compared to 13% of urban and 9% of suburban adults (Anderson, 2018).

FIGURE 1. Percentage of U.S. Adults Who are Home Broadband Users, by Family Income, Race/Ethnicity, and Residential Setting



Source: Pew Research Center. (2019). *Internet/Broadband Fact Sheet.*

FIGURE 2. Percentage of Cellphone-Dependent Adults in the U.S. by Family Income, Race/Ethnicity, and Residential Setting



Source: Pew Research Center. (2019). *Internet/Broadband Fact Sheet.*

DIGITAL DIVIDES IN COLLEGE

Although the overall U.S. digital divide was clearly observable and widely discussed prior to COVID-19, college students were rarely mentioned in the digital divide research because most colleges offer robust Internet access across campus libraries, classrooms, and residence halls, and many off-campus students live in highly-wired neighborhoods near campus (Galanek et al., 2018; Gierdowski, 2019). For students who cannot afford well-performing laptops or desktops, campus computer labs and libraries also provide free access to these devices (e.g., see Regalado & Smale, 2014).

Despite these advantages, some college students remained "underconnected." For example, among college students who commuted in 2018, 28% reported having subpar Internet access (Galanek et al., 2018). Other studies found that some college students had difficulty paying their Internet bill on time, struggled with data caps or outdated connection hardware, or could not complete academic work due to computer performance issues (Gonzalez et al., 2020; Rideout & Katz, 2016). These studies suggested that having reliable high-speed Internet and a well-performing tablet, laptop, or desktop is critical to college students' academic success (Gonzalez et al., 2020; Reisdorf et al., 2020). For example, a study of students at a Midwestern university found that, after controlling for socioeconomic status and other demographic factors, students with more poorly-functioning laptops had lower GPAs (Gonzalez et al., 2020).

The potential for growing digital divides in college became evident as institutions responded to the COVID-19 pandemic. In March 2020, colleges across the country pivoted to remote learning for students in traditionally face-to-face courses. In a nationally-representative survey of undergraduate students who experienced the online transition (Means & Neisler, 2020), students described several features of their online courses which require robust Internet access, including live discussion sessions (67%), recorded lectures (65%), frequent quizzes (64%), live lectures (60%), pre-recorded videos (55%), and live breakout groups (25%). At the same time, students lost access to several key sources of broadband Internet and desktop computing, as campus libraries, computer labs, and residence halls were emptied, and coffee shops, public libraries, and community centers closed their doors.

To understand the extent and impact of the digital divide on college students during this period, multi-institutional surveys of colleges or their students are reviewed and discussed below. To provide a lens specific to the Midwest, results are also presented from a survey of over 9,500 undergraduates and over 2,300 instructors across all 14 campuses of Indiana University and The Ohio State University (the "Indiana-Ohio" survey), which was conducted from April to June 2020.[3] Taken together, the survey results indicate that many students had inadequate technology – including poor Internet access or lack of access to a device necessary to complete academic work online – which thwarted students' academic experience and success. Technology use statistics are disaggregated by race/ethnicity, family income, and residential setting when possible.

Prevalence of Inadequate Technology

National and Midwestern surveys of technology use among college students suggest that inadequate technology has been a common barrier during the COVID-19 pandemic. In May 2020, the Congressionally-authorized non-profit organization Digital Promise conducted a nationwide survey of around a thousand undergraduates, including both two- and four-year college students (Means & Neisler, 2020). Digital Promise found that 16% of undergraduates had Internet connectivity issues which "often" or "very often" hindered their ability to participate in coursework. These rates were higher among Black and Hispanic students (17% and 23%, respectively) than among White students (12%). Connectivity problems were also higher among students from households earning under $50,000 (20%) than from households earning over $100,000 (12%) but did not differ statistically between students from suburban/urban communities (16%) and those from rural communities (14%).

In terms of computer hardware, nearly 80 percent of students in the Digital Promise study reported using a laptop for remote learning during the pandemic, whereas other students relied on a desktop computer (15%), a tablet (3%), or a smartphone (2%). About 8% of students reported experiencing serious hardware or software problems that interfered with their coursework often or very often, though these rates were higher among Black and Hispanic students (15% and 10%, respectively) than among White students (6%); and they were higher among students from households earning under $50,000 (11%) than among students from households earning over $100,000 (4%) (Means & Neisler, 2020).

The Indiana-Ohio survey found similar levels of technology inadequacy across students. Approximately 19% of undergraduates reported having inadequate technology of some type for full participation in online learning, with students reporting inadequate Internet access (11%), inadequate hardware (8%), or primary reliance on a cellphone (8%).[4] Similar to the Digital Promise findings, the Indiana-Ohio survey found that students from underrepresented racial and ethnic groups were substantially more likely than White students to deal with inadequate technology (see Table 1). For example, the rate of technology inadequacy was around ten percentage points higher among Black students (28%) than among White students (18%).[5] Levels of inadequate technology were also higher among students from small-town or rural areas (21%) in comparison to those from suburban areas (16%).

In addition to technology gaps by race/ethnicity and residential setting, the Indiana-Ohio survey revealed digital divides by academic class and institutional type. Table 1 shows that freshmen and sophomores were more likely to experience inadequate technology than upperclassmen.[6] Regarding institutional type, the results indicated that technology barriers were more common at regional or comprehensive universities, which tend to serve more students from disadvantaged backgrounds than do flagship research universities.

TABLE 1. Percentage of Indiana-Ohio Respondents with Inadequate Technology by Race/Ethnicity, Residence, Class Standing, and Institutional Type

	Ohio State University	Indiana University	Combined
All Students	**20%**	**18%**	**19%**
Race / Ethnicity			
African-American	29%	28%	28%
Asian-American	20%	17%	19%
Hispanic	28%	24%	25%
White	19%	17%	18%
Other	15%	15%	15%
Residential Setting			
Urban	20%	16%	18%
Suburban	16%	16%	16%
Small Town/Rural	25%	20%	21%
Class Standing			
Freshman	23%	25%	24%
Sophomore	23%	21%	21%
Junior	20%	17%	18%
Senior	18%	15%	16%
Type of Campus			
Flagship	19%	17%	18%
Regional	26%	21%	22%

Source: Authors' analysis of Indiana-Ohio COVID-19 survey data. Table excludes international students; the category "Other" combines domestic U.S. race/ethnicity groups which had a low number of responses to the survey, including Native American students and those who identified with Two or More Races.

Inadequate Technology and Student Success

Several surveys fielded during the pandemic revealed that many students experienced multiple academic challenges while engaging in online learning. For example, a survey by the SERU university consortium, conducted from May to July 2020 with over 30,000 undergraduates across nine public research universities (Soria et al., 2020; Soria & Horgos, 2020), found that 76% lacked motivation for online learning (see Table 2).

More than half of students also reported a lack of interaction with other students, the inability to learn effectively, and a lack of access to an appropriate study space as obstacles to success. SERU did not report these data by race or residential setting; however, they did divide respondents into five categories of social class and found that low-income students were significantly more likely than higher-income students to lack necessary technology (30% versus 10%) (Soria & Horgos, 2020).

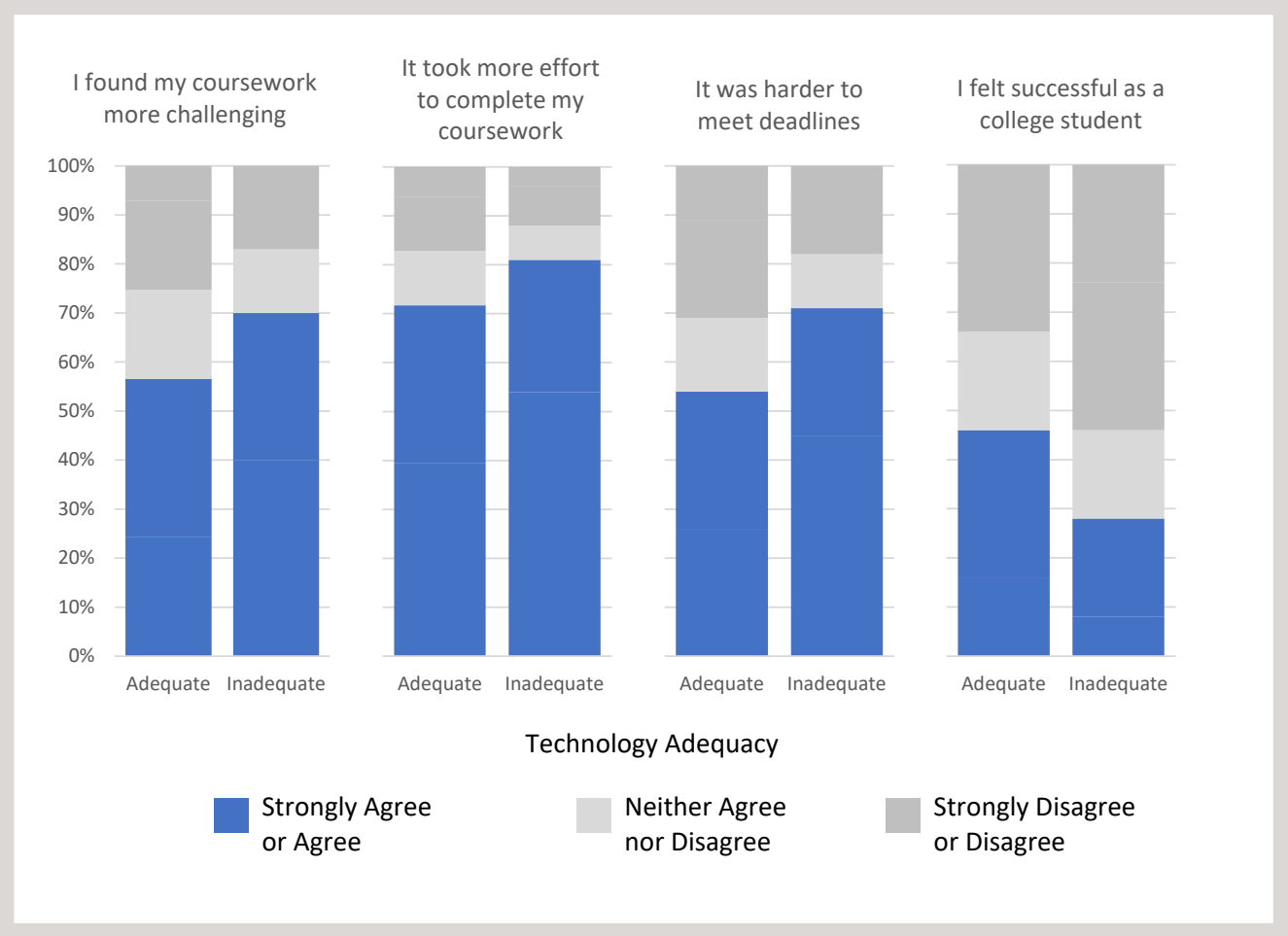
TABLE 2. Obstacles to Online Learning during the COVID-19 Pandemic Among Undergraduate Students at Public Research Universities in the U.S.

Type of Obstacle	Percentage of Students who Experienced Obstacle
Lack of motivation for online learning	76%
Lack of interaction/communication with other students	64%
Inability to learn effectively in an online format	61%
Distracting home environment or lack of access to an appropriate study space	56%
Course content that is not appropriate for online learning	43%
Lack of clear expectations for online learning from instructor(s)	39%
Lack of access to your instructor(s)	28%
Lack of access to academic advising	19%
Inability to attend classes at their scheduled online meeting time	18%
Inability to access learning support services	16%
Lack of access to technology necessary for online learning	16%
Lack of familiarity with technical tools necessary for online learning	14%

Source: Soria et al. (2020) *The obstacles to remote learning for undergraduate, graduate, and professional students.*

Among students without adequate technology, the academic experience was likely even more problematic. As noted earlier, research prior to COVID-19 suggested that inadequate technology is negatively associated with overall college performance, even when controlling for socioeconomic background (Reisdorf et al., 2020). Across the multi-institutional and national surveys conducted during the COVID-19 emergency transition, only the Indiana-Ohio survey examined how technology access influenced students' academic experience and success during this period.[7] As Figure 3 shows, Indiana-Ohio survey respondents with inadequate technology were more likely than their peers to agree that after the switch to online learning, coursework became more challenging, took more effort, and that they had a harder time meeting deadlines. Moreover, only 28% of students *without* adequate technology felt successful as a college student, compared to 46% of students *with* adequate technology.[8]

FIGURE 3. Relationship between Technology Adequacy and Student Perceptions of Success



Source: Authors' analysis of Indiana-Ohio COVID-19 survey data.

During the COVID-19 crisis, students dealt with a wide variety of financial and personal challenges; having inadequate technology seemed to exacerbate the impact of those challenges on students' academic success. For example, a student in the Indiana-Ohio survey commented:

> *I think everyone, instructors, university, students had the rug pulled out from under them, but I couldn't devote the focus to schoolwork because half my brain was busy having fits wondering if I can afford to keep living. I used the food banks and got some resources without spending money, but it didn't feel like enough especially since my internet plans and configurations depended on using/being on campus.... There was so much insecurity and instability during this time. My grades and schoolwork reflect that.*

While students' subjective assessment of their success is important, more objective measures are also critical to inform policy and practice. In order to understand whether technology inadequacy interfered with students' academic performance, an analysis was conducted to determine which students at Ohio State chose to switch to a "Pass / No Pass" (P/NP) grading option for their Spring 2020 courses.[9] Students who opt for a P/NP grading option may do so for various reasons, but poor course performance was the most common reason in Spring 2020.[10] The analysis showed that Ohio State students with inadequate technology were more likely to switch to P/NP for at least one course: 43% of students with inadequate technology did so, compared to 34% of students with acceptable technology (a difference of 9 percentage points). After controlling for the student's prior GPA as well as the background variables listed in Table 1, a difference of 7 percentage points persisted across all demographic groups.[11] Yet because African-American and Hispanic students were disproportionately likely to face inadequate technology, they were also more likely to switch to P/NP: overall, 46% of African-American students and 39% of Hispanic students switched to P/NP in Spring 2020, compared with 35% of White students. (See the Appendix for more detailed results.)

THE IMPACT OF INSTITUTIONAL TECHNOLOGY PROGRAMS

College and university administrators are well aware that students have encountered technology barriers during the pandemic. In April 2020, Educause – a non-profit association of colleges and companies focused on higher education information technology – conducted a poll of 267 two-year and four-year colleges in order to understand whether students had the technology necessary for remote learning. Across colleges, 36% of administrators reported that students were having "moderate or extreme difficulty" with Internet access, and 26% reported that students had the same level of difficulty with equipment and devices. In response, 81% of colleges were loaning laptops to students, 47% were loaning hotpots, and 28% were negotiating with vendors to provide free or discounted equipment to students (Grajek, 2020).

Such lending programs tend to operate on a small scale, as it is time- and cost-intensive to identify individual students who are truly in need, and to procure and deliver equipment to them. Furthermore, little research exists regarding whether investments in a large-scale technology program would have a significant impact on the various digital divides in college.[12] Data from the Ohio-Indiana study were thus analyzed to help address this issue. In contrast to Indiana University, Ohio State already had a large-scale technology provision program in place: since 2018, Ohio State has provided iPad Pros to every new first-year student.[13] Thus, one might expect Ohio State students to report substantially lower levels of technology inadequacy, compared to similar students at Indiana University. Indeed, in their open-ended comments on the survey, many Ohio State students indicated that the university-provided iPad was their primary device for completing coursework. One student commented:

> *The university iPad was much needed as it is my only computer-like device available right now with libraries closed and I am living at home with no computer access and no laptop. Its tools were therefore vital for me to be able to perform coursework, and very helpful in general.*

While student comments provided important qualitative evidence supporting Ohio State's technology program, a quantitative analysis of rates of technology inadequacy between Ohio State and Indiana University revealed mixed results. Specifically, a comparison of Ohio State and Indiana University students found no differences in rates of technology inadequacy, yet Ohio State students were significantly more likely to "strongly agree" that their device was adequate (67% vs. 57%, respectively).[14] The absence of a larger difference in the rate of technology inadequacy may

be due to the fact that Ohio State's iPads are WiFi only. For example, one student commented:

> *There is no internet provider where I live who services the area, so my family couldn't get internet connection even if we could afford it. A hotspot provided either in the software of the iPad or just a hotspot device would have been extremely helpful to allow me to work on my assignments in my home.*

In general, for students who returned home to a residence without broadband wireless, the WiFi-only iPad would not be very useful for academic work.[15]

STATE POLICY APPROACHES IN THE MIDWEST

When the COVID-19 pandemic struck, several Midwestern states had already taken steps to expand broadband Internet access, and the pandemic has further heightened the need to move forward with those legislative efforts. Over the past two years, Midwestern states' policies regarding broadband have clustered into four key areas: streamlining bureaucratic and regulatory models, supporting community and private sector engagement and training, leveraging state resources, and making other financial investments in broadband access. Below we provide an overview of each area, along with illustrative examples.

Streamlining Bureaucratic and Regulatory Models

Across the country, regulatory frameworks for telecommunications and electricity were developed prior to the advent of broadband, and these frameworks may need updates to reflect the critical role of broadband in daily life. Several Midwestern states have recently passed legislation to remove barriers for collaboration with telecommunications companies or broadband service providers to construct or improve telecommunications facilities (Cash, 2019). These laws recognize the importance of leveraging electric corporations and incentivizing electric cooperatives to work with the State to improve broadband. For example, Missouri's Electrical Corporation Broadband Authorization Act authorizes an electrical corporation to own, construct, install, maintain, repair, and replace broadband infrastructure, and to enter into contracts with broadband affiliates with shortened approval processes. The Act also reduces administrative barriers to expedite expansions of broadband access (Morton, 2020). Several states in the Midwest have also proposed legislation to limit contract awards or procurements to service providers which adhere to principles of net neutrality (Morton, 2019).[16] As part of their regulatory reforms, states have put a particular emphasis on wireless broadband. For example, Wisconsin passed legislation to facilitate the deployment of wireless equipment by wireless service companies,[17] and Nebraska gave wireless providers public rights-of-way access to provide services.[18]

Supporting Community and Private Sector Engagement and Training

In many underserved areas, Community Anchor Institutions (CAIs) play a key role in broadband adoption and education. According to the Federal Communications Commission (2011), CAIs are entities such as government offices, schools, colleges, or libraries that "provide outreach, access, equipment, and support services to facilitate greater use of broadband service by vulnerable populations, including low-income, the unemployed, and the aged" (p. 17700). Targeted legislation can help bolster CAI efforts. For example, Michigan's MERIT Network is a non-profit organization governed by Michigan's public universities that operates almost 4,000 miles of fiber-optic infrastructure in the state. The state's Broadband Technology Opportunities Program provided funding for MERIT to extend critical broadband service to community anchor institutions in rural and underserved communities (Sallet, 2019).

In addition to partnerships with CAIs, states have supported community efforts through the creation of broadband certifications and trainings. For example, Indiana now offers Community Broadband Certifications, which send a signal to stakeholders that the community is ready for infrastructure investment (Office of Lieutenant Governor Suzanne Crouch, 2020). However, the onus is on the community to seek out and acquire the investment. CAIs can help communities assess the costs and benefits of broadband investment and support communities through the planning process. For example, the University of Missouri has developed a toolkit for community broadband assessment and planning and is currently piloting its implementation with Bollinger County (Denkler et al., 2020).

Leveraging Federal Funding and State Administration

During the COVID-19 crisis, states used CARES Act funds, other COVID-19 relief funds, and other federal funding to provide devices and hot spots to students without access. For example, North Dakota allocated 10% of its CARES Act Elementary and Secondary School Emergency Relief Fund to K-12 schools that needed support with technological capacity, remote learning, and other emergency needs (North Dakota Department of Public Instruction, 2020). Ohio allocated $50 million of the state CARES Act funding to provide hotspots and Internet-enabled devices to K-12 students (Ohio Department of Education, 2020).

While states have been creative with the ways they navigate restrictions on federal funding to narrow the digital divide during COVID-19, many cities, colleges, and companies have implemented their own strategies to expand broadband access. However, such efforts were not always coordinated with each other or with the state's larger strategy. Consequently, some states created a centralized state office to streamline, coordinate, and support the administration of state and local regulation, programs, and funding to expand broadband (Morton, 2019, 2020; Stauffer et al., 2020). For example, in 2019 Illinois created the Office of Broadband within the state's Department of Commerce and Economic Opportunity, which implements the Connect Illinois broadband infrastructure grant program and related programing. Such offices provide a valuable opportunity to create a statewide vision for broadband and to coordinate the implementation of that vision through multiple public and private entities within the state.

Making Direct Investments

States are beginning to invest directly in broadband through grant programs, tax incentives, and user subsidies. For example, Minnesota's Border-to-Border Broadband Grant Program provides resources to motivate new and existing providers to invest in building broadband infrastructure in unserved and underserved parts of the state. The grant provides up to 50% of a project's infrastructure costs. Thus far it has connected 3,400 households, 5,200 businesses, and 300 community institutions across the state to ensure equitable access (Minnesota Office of Broadband Development, 2018, 2020).

Some states are also providing tax incentives for broadband service providers and subsidies for low-income households.[19] For example, Wisconsin exempted from the telephone company tax any property used to provide broadband service to a rural or underserved area.[20] Illinois is working to pass the Low-Income Broadband Assistance Program, which would directly pay a portion of the monthly broadband bill for low-income households.[21]

CONCLUSION

Whether classes are interrupted by a pandemic, a climate event, or other public emergency, the ability of students to continue their studies and maintain academic progress depends on access to computer hardware and robust Internet access. However, in colleges across the country, including in the Midwest, approximately 16% - 19% of students lack the technology necessary to fully participate in online learning. Further, this report documented significant digital divides by family income, race and ethnicity, and residential setting. Higher rates of technology inadequacy during the COVID-19 pandemic were observed among lower-income students (20%-30%) than higher-income students (10%-12%); Black (17%-29%) and Hispanic (23%-28%) students relative to White students (12%-17%); and students living in a rural area (14%-25%) compared to those living in a suburban (16%) or urban area (16%-20%). Regardless of demographic or academic background, technology inadequacy creates an academic struggle for students and threatens their academic success. As a result, current continuity planning may have the unintended consequence of magnifying inequities among students who are already marginalized.

In order to strengthen academic continuity planning, states and institutions can work together to ensure that all students have access to adequate hardware and broadband Internet. Institutions might consider putting an emphasis on the provision of large-format, WiFi-enabled mobile devices (such as iPads or Surface tablets) which can remain with each student regardless of where they may find themselves in an emergency. For example, colleges might consider including this hardware as part of the standard financial aid package for students who receive need-based institutional aid. Colleges should also maintain a formal program for short- and long-term loans of tablets, laptops, and wireless hotspots for students who have a demonstrated need for these devices.

In turn, states would better serve all students by reviewing

their current broadband policies and legislation with an eye to equity to ensure that policies are expanding broadband access for rural, African-American, Hispanic, and other underserved populations. For example, states might consider investing in ubiquitous wireless broadband that would allow students to use mobile devices effectively from any location. Many colleges have already worked to make this vision a reality on and around their own campuses and are well-positioned to partner with community and state leaders to craft larger-scale implementations, such as citywide wireless broadband.

Based on an overview of legislation in the Midwest, several state policy options are worth considering:

- Streamline bureaucratic and regulatory models for telecommunications, including removing barriers for collaboration with broadband service providers.
- Support community and private sector engagement and training, by bolstering the efforts of Community Anchor Institutions and creating broadband certifications and trainings for communities.
- Leverage state administration to strategically allocate indirect federal funding to support technology access and to streamline, coordinate, and support the administration of broadband programs through a centralized state office.
- Invest directly in broadband through programs that incentivize or match private and local investment.
- In broadband expansion efforts, place a particular emphasis on wireless broadband to minimize infrastructure costs.
- Incentivize or support colleges in efforts to provide tablets, laptops, and wireless access to students who would otherwise have inadequate technology.

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APPENDIX

In order to understand whether technology inadequacy continued to predict P/NP after controlling for academic and demographic background, researchers conducted a logistic regression model with Ohio State undergraduate survey respondents, predicting the outcome of "switched to P/NP for at least one course in Spring 2020." To be consistent with Table 1, international students were excluded from the model.

Results are shown in Table A1. Reference categories represent the modal student: a White, Columbus-campus senior from a suburban area with a GPA of 3.40. Prior GPA is converted to a standardized scale with a standard error of 1 (or 0.56 GPA points). Interactions between Technology Inadequacy and other controls were not statistically significant and were dropped from the model. Predicted probabilities were calculated using modal values for each control. For example, for the modal student, the model suggests that 34% would switch to P/NP if they had adequate technology, while 41% would switch to P/NP if they were dealing with inadequate technology; this difference of 7 percentage points is reflected in the column "Change in Probability of P/NP."

TABLE A1. Logistic Regression Predicting P/NP Grades

Predictor	Logit (SE)	Change in Probability of P/NP
Inadequate Technology	0.28 (0.09)***	+ 0.07
Ethnicity: Black	0.13 (0.17)	+ 0.03
Ethnicity: Hispanic	- 0.01 (0.17)	0.00
Ethnicity: Asian	0.07 (0.14)	+ 0.02
Ethnicity: Other	0.06 (0.14)	+ 0.01
Campus: Regional	- 0.75 (0.14)***	- 0.14
Home: Rural / Small Town	- 0.02 (0.10)	- 0.01
Home: Urban	0.19 (0.09)	+ 0.04
Prior GPA	- 0.37 (0.04)***	- 0.08
Rank: Freshman	0.04 (0.16)	+ 0.01
Rank: Sophomore	0.06 (0.10)	+ 0.01
Rank: Junior	0.08 (0.09)	+ 0.02

*** $p < 0.001$

[1] In addition to the limitations of a small-format screen, students complain that cell service is often unreliable or slow due to data limits or saturation of the network (Fernandez, 2019). In Hampton et al. (2020), researchers asked students whether they sometimes left homework unfinished due to lack of computer or Internet access; 49% of cellphone-dependent students reported doing so, compared to 39% of those with slow home Internet and 17% of those with high-speed home Internet. Cellphone-dependent students reported an overall GPA of 2.75, compared to a GPA of 3.18 among students with high-speed Internet access – a difference which remained statistically significant after controlling for socioeconomic status and other demographic factors.

[2] For example, in the Hampton et al. (2020) study of Michigan 8th to 11th graders, only 37% of students with no home Internet were instead able to access the Internet at a friend's house – compared to 53% of students with high-speed home Internet.

[3] The two universities collaborated on a set of "core" items, and each also included items unique to that university's planning needs. This brief provides original analyses conducted by the authors. For overall reports from each survey, see Motz et al. (2020) and Jaggars et al. (2020). The Ohio State survey was conducted from mid-April to mid-May, closing just after students' final grades were posted; the IU survey was conducted from mid-May to mid-June, beginning just after the spring semester ended. Analyses regarding the representativeness of Ohio State student responses suggest that survey respondents were similar to the undergraduate population in most respects, including race/ethnicity, first-generation status, and the likelihood of having previously taken an online course; however, respondents were less likely to be international students and had slightly higher GPAs than the overall undergraduate population. IU's analysis of representativeness is in progress; however, IU's international students are known to be underrepresented due to an exclusion of students who were not currently residing in the U.S. at the time of the survey. It is also possible that students with the most inadequate technology were least likely to respond to the survey; accordingly, our estimates of technology inadequacy may be conservative.

[4] Students rated their level of agreement on a 5-point scale (from Strongly Disagree to Strongly Agree) for the following items: "I had adequate access to the Internet connectivity necessary to participate in remote instruction" and "I had adequate access to computer hardware necessary to participate fully in remote instruction." Inadequacy of Internet or devices were defined as strongly or moderately disagreeing with the relevant item. Responses to the two questions overlapped; for example, among those who disagreed they had adequate Internet, 42% also disagreed that they had adequate hardware. In addition to these two questions, students also selected the "primary method of connecting to the Internet to complete your online coursework," with one option being "mobile phone network data." Students selecting this option were defined as using a cellphone as their primary device. This question overlapped with the first two; for example, among those using a cellphone as their primary device, 40% disagreed that they had adequate access to the Internet. Students with inadequate Internet, an inadequate device, or who used a cellphone as their primary device were defined as having "Inadequate Technology." (Based on other responses on the survey regarding hardware, we suspect that the typical student with "inadequate technology" brought adequate hardware back to a family home with inadequate Internet, where they cobbled together a solution such as using their cellphone for streaming video, and using their laptop or wireless-only tablet for mostly-offline tasks.) All other students were defined as having "Acceptable Technology" (although not necessarily ideal technology; many of these students reported in other sections of the survey that they still had some challenges with limited Internet access). This definition of inadequacy is more strict than one used in an earlier Ohio State-specific report (which included students who "neither agree nor disagree" that they had adequate Internet/devices, see Jaggars et al., 2020) and thus yields slightly lower estimates of inadequacy. Data in Figure 1 is pooled across Indiana University and Ohio State surveys. These proportions were not significantly different between the two universities.

[5] Excludes international students; the category "Other" combines domestic U.S. race/ethnicity groups which had a low number of responses to the survey, including Native American students and those who identified with Two or More Races.

[6] It is not clear why underclassmen would be more likely to suffer from inadequate technology. Perhaps students with inadequate technology are more likely to drop out before graduation; or perhaps some freshmen require a few semesters to diagnose their true technology needs and to scrape together an appropriate solution to those needs.

[7] The Digital Promise analysis combined technology challenges into a larger scale that also captured six other challenges (such as not knowing where to get help with the course, or problems staying motivated to do well in the course). Results found that students with multiple challenges were less likely to be satisfied with their online courses; for example, among students with no challenges (including no technology challenges), 81% were satisfied or very satisfied with their online courses, while among students with four or more challenges (which may or may not have included technology challenges), only 32% were satisfied or very satisfied (Means & Neisler, 2020).

[8] Based on ordered probit analyses, differences in the distribution of responses for the Adequate versus Inadequate groups were statistically significant for each item.

[9] Many universities across the country offered students P/NP or similar grading options for Spring 2020. At Ohio State, the P/NP option was offered for all elective and general education courses, with a grade of D or above marked as "Pass," and a grade below D marked as "No Pass." Individual academic programs had the discretion to offer the P/NP option for major-specific requirements. Students were required to select the P/NP option by mid-April: four weeks after classwork pivoted to remote learning, and approximately two weeks before final exams.

[10] Open-ended survey comments and other qualitative feedback from students suggest that in Spring 2020, students switched to P/NP for a given course if they were struggling in that class. Relieving GPA-related stress about that course allowed students to put more time and effort into their remaining courses – and in particular, to focus on courses required for admission to selective majors or graduate programs which may not accept a P/NP grade. Examination of administrative data shows that C and D grades were largely replaced by Pass grades in the Spring 2020 semester.

[11] Researchers conducted a logistic regression model predicting the outcome of "switched to P/NP for at least one course in Spring 2020" with the primary predictor of technology inadequacy, covariates listed in Table 1, and an additional covariate of prior GPA. For more information, see Appendix Table A1.

[12] Almost all studies examining student laptop or device provision programs have focused on the K-12 sector; see Weston et al. (2010) for the most recent systematic review. In higher education, the only research summary is nearly two decades old (Kontos, 2002). Recent research is confined to case studies, with the most useful being focused on technology provision initiatives in the College of Education at Southeast Missouri State (Fridley & Rogers-Adkinson, 2016) and in 17 campuses across the United Arab Emirates (Hargis et al., 2014).

[13] Ohio State's iPad Pro package includes a pencil, keyboard, and a suite of learning apps. Transfer students who first enrolled at any college in Autumn 2018 or after are also included in Ohio State's iPad program. Among survey respondents at Ohio State, 98% of freshmen had a university-issued iPad, along with 94% of sophomores, 63% of juniors, and 11% of seniors.

[14] Results are based on a comparison between the two universities when controlling for the confounding factors listed in Table 1. To be consistent with Table 1, international students were excluded from the analysis. The difference between the two universities was statistically significant at $p < 0.001$, with most of the difference concentrated at the threshold between Agree and Strongly Agree. The model included interaction effects for class rank, given that we would expect to see an institutional difference most strongly among freshmen and sophomores, and to see little or no difference among seniors; while the results do pattern in this direction, the interaction pattern is not statistically significant.

[15] Providing a cellular-enabled device (at an additional cost of $150 per device) along with university payment of the student's monthly data charge would solve this problem. However, this approach is cost-prohibitive at the scale of Ohio State's program, which currently provides approximately 37,000 iPads to students.

[16] For an analysis regarding the rights of states to implement net neutrality standards, see Lundgren (2020). For proposed legislation in the Midwest, see H.B. 5094 (I.L. 2017), H.F. 3033 & S.F. 2880 (M.N. 2018), and L.B. 856 (N.E. 2018).

[17] See A.B. 235 (W.I. 2019)

[18] See Small Wireless Facilities Deployment Act, Neb. Rev. Stat. §86-1201. (2019).

[19] A potential drawback of tax credits for households is that many low-income individuals are not familiar enough with the tax code to leverage this kind of credit, see Dickert-Conlin, Fitzpatrick, & Hanson (2005).

[20] See Wisconsin Stat. §76.80 (2019)

[21] See H.B. 3491 (I.L. 2019)

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