# "A" for Access: The Effects of Pandemic Technology Maintenance Issues on College Students' Grades, Stress, and Coping

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## Abstract

*Campus lockdowns during the COVID-19 pandemic left some higher education students without access to reliable, high-quality digital technology. This research extends the technology maintenance construct—the idea that computing quality is consequential for quality-of-life–in a few key ways: by examining it in the novel context of emergency remote learning, by testing students' place of residence as a moderator of its effect on academic success, and by linking this construct to perceived stress and coping. In an analysis of representative survey data from a public university in California between February and July of 2020, we find that although Internet and computing quality were not associated with GPA pre-lockdown, they were during lockdown, particularly for students who remained on campus. Internet and computing quality also predicted students' stress and coping ability during lockdown. These data underscore the role of higher education institutions in expanding access to digital technology.*

**Keywords:** digital inequality, technology maintenance, remote learning, stress, coping

## 1. Introduction

In March of 2020, the global reaction to the highly contagious COVID-19 was largely to enforce strict social isolation guidelines. As commerce came to a halt worldwide, educators scrambled to determine how students would continue learning. Fortunately, in 21st century U.S. university settings, online learning was already becoming a normative practice (Nguyen, 2015). Yet, what had typically been the exception suddenly became the rule. This moment in history provided a unique opportunity to examine how digital inequalities might suddenly manifest with marked consequence. More specifically, we use the construct of *technology maintenance*, which emphasizes the quality and stability of digital infrastructure (Gonzales, 2014; 2016), to explore whether characteristics of digital access were associated with quality of life—specifically grades stress, and coping—for university students during the early weeks of the pandemic.

In this study, we present findings from a representative two-wave panel survey of university students to look at the relationship between the quality of internet service and computing devices and GPA immediately before and soon after the March 2020 U.S. lockdown. In doing so, we attempt to replicate the relationship between technology maintenance issues and U.S. university students' academic performance found prior to the pandemic (Gonzales et al., 2020) and during the lockdown (Katz et al., 2021). Moreover, because potential moderators of the effects of technology maintenance issues have largely been unexplored in prior work, we examine the moderating effect of staying on campus versus being at home during lockdown. Results of our analysis shed light on the essential roles that institutions such as universities play in supplementing the digital needs of the populations they serve. Furthermore, we contribute to the extensive body of research linking digital media access and stress by testing whether digital inequality affects students' perceived stress and ability to cope. Our findings underscore the critical function of technology maintenance for stress management, especially during exceptionally challenging circumstances.

### 1.1. Digital Divide Scholarship & Technology Maintenance

Certainly theorists, scholars, and practitioners have been aware of the compromising effects of poor access to digital technologies on quality of life long before COVID, including the negative effects it can have on education, employment, healthcare, and other daily life experiences (Arque et al, 2013; Bleakley et al., 2004; Gonzales et al., 2014; Katz et al., 2021; Livingstone & Helsper, 2012). This concept of digital or technology "access" is often a catch-all that refers

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to "complex questions of levels of connectivity in terms of the capability and distribution of the access concerned" (Selywn, 2004, p.348). To address these factors, scholars often target the tripart tools of broadband, computing devices, and sufficient digital skills, or the ABCD's of digital equity (i.e., access, broadband connectivity, devices; Katz & Jordan, 2020). In this paper, we pay particular attention to the role of devices and broadband access, concepts that many refer to as part of the "first-level" digital divide (van Deursen & van Dijk, 2019; van Dijk, 2005).

In his *resources and appropriations theory*, van Dijk (2005; 2020) notes that motivation and physical access are both components of the first-level divide. We focus on physical access, which is often conceptualized in its most basic form as in-home broadband and a large-screen computer, such as a desktop or laptop. Indeed, this principal form of physical access is critical for academic success, as well as access to health and job information (Arque et al, 2013; Bleakley et al., 2004; Katz et al., 2021; Livingstone & Helsper, 2012). However, scholarship on technology maintenance (Gonzales, 2014; 2016), or "the constant effort required to ensure stable [digital] access" (Gonzales, 2014, p .241) points out that low-income technology users disproportionately rely on devices and services that are broken, borrowed, and *dependably unstable*, cycling in and out of use. Previous work has found that this quality of access, rather than the categorical state of device or internet ownership or use, is associated with better student grades, lower patient stress levels, better digital skills, and better overall health (Gonzales et al., 2020; Gonzales et al., 2021; Read et al., 2021; van Deursen & van Dijk, 2019). In short, having stable, reliable physical access to the internet and high-quality devices is a key component of improving digital equity that reaches beyond simple ownership or use.

The benefits of stable, high-quality computing over basic access became exceedingly apparent during the COVID-19 pandemic. Many aspects of life were abruptly moved online, often demanding more sophisticated technology than many were accustomed to using (e.g., Zoom meetings, doctor portals, etc.). For instance, to connect with instructors, employers, healthcare providers, and loved ones via videoconference, it was not enough to have a basic computer and stable internet connection—one needed a camera, microphone, sufficient bandwidth, and proper knowledge of the system at hand. Thus, researchers quickly recognized that digital inequalities during COVID could have negative effects on stress and social support (Cheshmehzangi et al., 2022; Nguyen et al., 2021; Robinson et al., 2021), employment opportunities (Bloomberg et al., 2021; Robinson et al., 2020), and, perhaps most strikingly, education (Katz & Rideout, 2021; McClain et al., 2021). According to that research, many families struggled with the costs and know-how required to keep their children connected to their classrooms. This struggle, and the well-established role of technology in supporting education and mental health are outlined in further detail below.

## 1.2. Digital Technology & Academic Performance

Even before the pandemic, the effects of technology access and maintenance on academic performance were evident. Previous research has found that access to technology mediates the effects of student confidence and self-reliance on academic performance (Livingstone & Helsper, 2012; Robinson, 2014), and students frequently leverage communication technologies to facilitate collaboration, communication with lecturers, and interaction with class content (Hamid et al., 2015). Indeed, even prior to the pandemic, university students found a lack of computer access to be a disadvantage. Students without a PC had lower GPAs than their peers with PCs after controlling for sociodemographic factors (Reisdorf et al., 2020), and the time displaced by dealing with technology issues or accessing shared resources also undermined students' academic performance (Gonzales et al., 2020; Robinson, 2009).

Despite limited research on the effects of technology maintenance on academic performance since the start of the pandemic, the divide between those with and without dependable digital access has likely widened. One study reported that 16-19% of college students experienced limited technology access during the pandemic which inhibited academic performance; furthermore, only 28% of those students reported feeling successful in an online learning environment (Jaggars et al., 2021). In addition, Jaggers and colleagues (2021) found that college students with limited technology access experienced greater challenges completing their coursework and were significantly more likely to opt for a "Pass/No-Pass" grade in spring of 2020. Katz and colleagues (2021) also found that connectivity and device challenges were associated with lower self-reported remote learning proficiency among university students during the spring 2020 semester (Katz et al., 2021).

Given these findings, our first goal was to assess the extent to which lower quality access to technology was associated with poorer academic performance prior to, and then during the pandemic (i.e., winter 2020 and spring 2020, respectively). Unlike the study by Katz et al. (2021), which measured students' self-

reported remote learning proficiency, we used students' GPA as our outcome variable, which was supplied by the institution.

**H1a:** Lower quality access to technology is associated with a lower GPA in winter of 2020 after controlling for demographic factors.

**H1b:** Lower quality access to technology is associated with a lower GPA in spring of 2020 after controlling for demographic factors.

Meanwhile, previous research on the digital divide in higher education has pointed to the role of shared, public resources in expanding access to technology. Prior to the pandemic, university students reported relying upon campus libraries and computer labs when they were unable to afford their own PCs or when experiencing issues with their computers (Gonzales et al., 2020; Reisdorf et al., 2020). Unfortunately, in many places these resources were temporarily inaccessible when college campuses worldwide closed due to COVID-19. Because campus closures were initially predicted to last only a few weeks, higher education institutions may not have made the necessary arrangements to ensure that every student had adequate access to technology during the early stages of the pandemic. For example, students at the university where the present study was conducted were offered the opportunity to borrow a Chromebook when campus went into lockdown, although only 300 of these computers were available on a first come, first served basis. At our campus, initiatives such as reimbursement from the university for home internet access did not begin until after our data were collected.

For these reasons, students' access to digital technology likely varied considerably during the early months of the pandemic. Those students who remained on campus, in many cases, did not have continued access to campus resources. At the same time, those students who moved back home with their parents did not have guaranteed Wi-Fi or access to loaner laptops provided by the university. Given mixed possible implications of location, we pose the following research question:

**RQ1:** Does the relationship between quality of access to technology and GPA differ between those who moved back home with their families in spring of 2020 and those who did not?

## 1.3. Digital Technology, Stress, & Coping

The pandemic was a source of stress for people globally, as societies people were forced to cope with unpredictable new circumstances. *Psychological stress* describes the perception that the demands in one's environment exceed one's ability to adequately cope (Lazarus & Folkman, 1985), whereas *coping* refers to any efforts to remove or diminish the negative effects of a threatening or harmful situation (Carver & Vargas, 2011). The better one's ability to cope, the less stress one will perceive eventually.

There are a couple of reasons to suspect that digital disruption during the early days of the pandemic was associated with individuals' perceived stress and ability to cope. First, uses and gratifications theory (Katz et al., 1973) explains how people use media deliberately to gratify psychological needs, including cognitive or informational needs, affective or emotional needs, social or relational needs, and the need for escapism. Indeed, Eden et al. (2020) reported that perceived stress during the pandemic was positively associated with the use of escapist and avoidant media-based coping strategies, and Pahayahay and Khalili-Mahani (2021) documented that greater stress was associated with increased screen-time and greater reported use of media to cope, especially for those struggling with their mental health. Moreover, Nabi et al. (2022) reported that listening to music or watching a TV show or movie mediated the effects stress related to COVID-19 on perceived coping efficacy among American adults. Thus, many people depended upon media to gratify various psychology needs during the pandemic, but it remains unclear what people's experiences were like when they had unstable access to digital media.

A second reason that digital disruption should predict people's perceived stress and ability to cope is that the experience of digital disruption is inherently stressful. Some researchers have documented a phenomenon known as *nomophobia*, defined as "discomfort or anxiety caused by the non-availability of [a mobile phone], PC or any other virtual communication device in individuals who use them habitually" (King et al., 2013, p. 131). People feel a strong attachment to their digital devices, and being without their devices—especially under uncertain or uncontrollable circumstances (Tams et al., 2018), for longer periods of time (Kneidinger-Müller, 2019), or at times when they are other challenges (Wolfers et al., 2020)—is a source of acute distress, even when an alternative communication device is available (Nie et al., 2020). The consequences of digital disruption may have been particularly stressful during the pandemic, when people were more reliant on their devices than ever before.

To study the effects of access to technology on mental health during the pandemic, we propose the following hypotheses:

**H2:** Lower quality access to technology is associated with greater perceived stress in spring of 2020 after controlling for demographic factors.

**H3:** Lower quality access to technology is associated with a reduced capacity to cope with stress in spring of 2020 after controlling for demographic factors.

## 2. Method

The present study was conducted to address a few research objectives. First, this study examines the effect of the quality of university students' digital technology on their GPA at two timepoints shortly before and after the campus went into lockdown. Second, we sought to test whether students remained on campus during the lockdown or moved home with their families as a potential moderator of that relationship, thereby assessing the assumed importance of access to campus resources for technology maintenance. Third, we look at the effects of digital inequality on students' perceived stress and ability to cope at the start of the pandemic.

### 2.1. Participants & Procedure

A random sample of 4,000 undergraduate and 1,500 graduate students at a public university in California were invited to participate in an IRB-approved online survey about their experiences with digital disruption and technology repair. The survey ran from February to April of 2020. 1,290 students opened the survey (23.5% response rate), and 955 submitted complete responses (17.4% completion rate). Those who completed the survey, which took about 25 minutes, were entered into a raffle to win one of five $50 Amazon gift cards.

Halfway through data collection, the COVID-19 pandemic resulted in the closure of campus and forced relocation of many students living in campus housing. Due to this unforeseen event, a second survey was sent out in June and July to those who participated in the first survey. This survey included many of the same questions in addition to some new items related to the challenges students faced during the pandemic and their ability to cope. Those who completed the survey, which took about 25 minutes, received a $5 Amazon gift card and were entered into a raffle to win a $100 Amazon gift card. In total, 467 students completed both surveys (a 51% retention rate).

The final sample (N= 467) was made up of 62.7% undergraduates and 37.3% graduate students. Participants had a mean age of 23.8, with 16.7% of the sample in their teens, 70.7% in their twenties, 11.1% in their thirties, and 1.9% in their forties or above). About two-thirds (66.2%) identified as female, close to one third (33.2%) identified as male, and three individuals did not identify as male or female. A handful of students (4.3%) in this sample were residing in a country other than the United States at the time they completed the second survey. The sample was somewhat racially diverse—38.1% identified primarily as white, 23.8% Asian/Pacific Islander, 13.1% Chicano, 5.1% Latino, 2.6% Pilipino, 2.1% African American, 1.9% East Indian/Pakistani, and .9% Native American—although African American's were unrepresented relative to the larger college student population in the United States. Primary ethnicity was unknown for an additional 12.4% of the sample. In general, the demographics represented are similar to the university's student population. Females are overrepresented, which is typical of institutionally administered surveys at our university.

The demographics of those who completed both surveys were compared to those who only completed the first survey using a series of Pearson's chi-squared tests. There were significantly larger proportions of females ($X(1) = 5.17$, $p = 0.02$), graduate students ($X(1) = 10.60$, $p = 0.001$), and Asians/Pacific Islanders ($X(1) = 16.10$, $p < 0.001$) among the former group compared to the latter group. However, we controlled for these demographic variables in our analyses.

### 2.2. Measures

*Technology Access.* Students' access to technology was assessed using a few different measures. First, at both timepoints, respondents with PCs rated on a five-point scale how well their computer worked (1 = *did not work*, 5 = worked perfectly) and how satisfied they were with the quality of their computer (1 = *very dissatisfied*, 5 = *very satisfied*), and these items were averaged to create a composite score where higher values indicated higher PC quality. Next, at time two, students reported whether their PC had ever been inaccessible or unusable at any point during the spring 2020 quarter. If they responded that their PC had been inaccessible, they were asked to report how many days they were without a computer (1-3, 4-6, 7-14, 15-30, or 30+ days). Responses were aggregated into two categorical variables indicating whether students were without a computer for 1-3 days (0 = *no*, 1 = *yes*) or 4+ days (0 = *no*, 1 = *yes*). Lastly, in the second survey, students also rated the quality of their internet connection in their primary residence (if they had one) during the winter 2020 quarter (retroactive) and during the spring quarter on a five-point scale (1 = *very dissatisfied*, 5 = *very satisfied*).

*GPA.* Students' official, non-cumulative GPAs for the winter 2020 and spring 2020 quarters were provided by the university and appended to their survey responses.

*Stress & Coping*. In the second survey only, stress and coping were measured using the 10-item perceived stress scale by Cohen et al. (1983; see Appendix A). The scale asks respondents to rate how often they have experienced certain thoughts or feelings over the past month on a 5-point scale (0 = *never*, 4 = *very often*). For six of the items (e.g., "In the last month, how often have you felt nervous and 'stressed'?"), higher scores indicate greater perceived stress, whereas for the other four items (e.g., "In the last month, how often have you felt confident about your ability to handle your personal problems?"), higher scores indicate greater perceived coping ability. An exploratory factor analysis with all ten items suggested a two-factor solution based on a parallel analysis scree plot. The six stress-related and four coping-related items clearly corresponded to separate factors with loadings of at least 0.5. We averaged participants' responses to the stress-related items as a measure of perceived stress ($\alpha = .80$), and we averaged their responses to the coping-related items as a separate measure of perceived coping ability ($\alpha = .72$)[1].

*Gender*. Participants' reported gender was dummy-coded such that males were coded as 0 and females were coded as 1. Those who did not identify with either gender were treated as missing on this variable.

*Grade Level.* A dummy variable was created to indicate whether students were undergraduates (0) or graduate students (1). Next, additional dummy variables were created for each of the various undergraduate class levels (sophomores, juniors, seniors), where freshmen served as the reference category.

*Race/Ethnicity*. Participants' primary race/ethnicity was obtained from the university and aggregated into several dummy variables indicating whether they were Asian/Asian American, Black/African American, Latinx/Chicano, White, or another ethnicity (0 = *no*, 1 = *yes*). "White" was used as the reference category in our analyses.

*Parental Education.* Previous studies involving students in higher education have used parental education as a proxy for socioeconomic status (e.g., Gonzales et al., 2020). In our study, data obtained from the university reported the highest level of education completed by either of respondents' parents (1 = *no high school*, 2 = *some high school*, 3 = *high school graduate*, 4 = *some college*, 5 = *2-year college graduate*, 6 = *4-year college graduate*, 7 = *post-graduate study*). This was treated as a continuous variable in our analyses.

*Essential Work.* At time two, students were asked whether they were considered an essential worker (i.e., someone who cannot work from home). Those who said no received a code of 0, and those who said yes received a code of 1.

*Pandemic Place of Residence.* The time two survey asked students to report where the primarily resided during the winter 2020 (pre-pandemic) and spring 2020 (early pandemic) quarters. Those who reported living with family in the spring but not the winter, meaning that the pandemic forced them to move home, were given a code of 1, and everyone else was given a code of 0.

See Table 2 and Table 3 for bivariate correlations.

## 3. Results

### 3.1. Descriptive Findings

In winter of 2020, just prior to the pandemic, nearly all students in our sample (98.5%) reported having an internet connection at home. This was still the case in spring of 2020, just after the shutdown, where 99.4% of students had a home internet connection. However, whereas 9.9% of students reported that they were dissatisfied or very dissatisfied with the quality of their internet in the winter, 14.4% of students were dissatisfied or very dissatisfied in the spring. In terms of PC quality, 1.9% of students in the winter and 2.1% in the spring reported that their PCs were low-quality (rated 2 or below on a 5-point scale). Digital disruption was not uncommon during the spring of 2020—11.3% of students reported a time when their PC was completely inaccessible or unusable, and 8.5% of students were without a computer for at least four days. Taken together, these findings reveal that although most students were able to secure physical access to digital technology before and during the pandemic, many struggled to maintain access, finding themselves with a spotty internet connection or temporarily without a computer.

[1] Often, researchers recode the four coping items and then aggregate all ten items into a composite score of perceived stress. However, some studies (e.g., Roberti et al., 2006) have treated the two sets of items as separate measures of perceived distress and perceived coping, as we did in this study.

**Table 1. Summary of hypotheses and results**

| Hypothesis | | Technology Access Predictors | | | | |
|---|---|---|---|---|---|---|
| | | Internet Quality | PC Quality | No PC 1-3 days | No PC 4+ days | Result |
| H1a | Lower quality access to technology is associated with a lower GPA in winter of 2020 after controlling for demographic factors. | ß = -0.01<br>*p* = .84 | ß = -0.02<br>*p* = .75 | -- | -- | Not supported |
| H1b | Lower quality access to technology is associated with a lower GPA in spring of 2020 after controlling for demographic factors. | ß = 0.22<br>*p* = .003 | ß = 0.17<br>*p* = .03 | ß = -0.28<br>*p* = .23 | ß = -0.62<br>*p* = .02 | Supported |
| H2 | Lower quality access to technology is associated with greater perceived stress in spring of 2020 after controlling for demographic factors. | ß = -0.13<br>*p* = .06 | ß = -0.19<br>*p* = .01 | ß = 0.21<br>*p* = .31 | ß = .49<br>*p* = .04 | Partially supported |
| H3 | Lower quality access to technology is associated with a reduced capacity to cope with stress in spring of 2020 after controlling for demographic factors. | ß = .25<br>*p* < .001 | ß = .17<br>*p* = .01 | ß = -0.03<br>*p* = 0.88 | ß = -0.39<br>*p* = .12 | Mostly supported |

## 3.2. Technology Access & Grades

*Winter 2020 (Pre-Pandemic).* Hypothesis 1a predicted that lower quality access to technology would be associated with a lower GPA for the winter 2020 quarter (non-cumulative) after controlling for sociodemographic factors. A hierarchical linear regression analysis was used to test this hypothesis among those who completed both surveys. First, model 1 revealed that covariates alone (whether students lived on campus, parent education, gender, year in school, and race) explained 16.8% of variance in winter GPA, $F(185) = 4.83$, $p < .001$. Adding winter internet quality as a predictor in model 2, winter PC quality in model 3, and both internet and PC quality in model 4 did not significantly improve model fit. Neither winter internet nor PC quality were significant unique predictors of GPA in any model. These results do not support H1a[2].

*Spring 2020 (Post-Pandemic).* Hypothesis 1b predicted that lower quality access to technology would be associated with a lower GPA for the spring 2020 quarter (non-cumulative) after controlling for sociodemographic factors. A hierarchical regression analysis was conducted to examine the predictors of students' GPA in the spring of 2020. In model 1, covariates alone explained 12.8% of variance in spring GPA, $F(190) = 2.22$, $p = .01$. Spring internet quality was added in model 2 and was a significant predictor of GPA, ß = 0.22, $p = .003$. In model 3, spring internet quality was replaced with PC quality, which was also a significant predictor of GPA, ß = 0.17, $p = .03$. In model 4, spring PC quality was replaced with two dummy variables representing whether students had experienced a time when their PC was inaccessible for 1-3 days or at least 4 days during the spring quarter. Going without access to one's PC for 1-3 days was not a unique predictor of GPA (ß = -0.28, $p = .23$), but going without access for 4 or more days was (ß = -0.62, $p = .02$). Finally, in model 5, all of technology access predictors were entered simultaneously. In model 5, spring internet quality was the only technology access variable that significantly predicted GPA[i], ß = 0.18, $p = .02$. Models 2-5 each explained a significantly larger portion of variance in spring 2020 GPA relative to model 1 ($p < .05$). Overall, these results support H1b[3] (see Table 4).

*Role of Campus Closure.* RQ1 asked whether the relationship between quality of access to technology and GPA differed between those who moved back home with their families in spring of 2020 and those who did not. Upon reviewing the regression models

[2] A separate analysis tested H1a among the full sample of participants who completed the first survey prior to campus closure, regardless of whether they completed the second survey. As was the case for those who completed both surveys, there was no support for H1a for those who only completed the first survey.

[3] Given that spring PC quality was highly correlated with having one's PC inaccessible for 1-3 days ($r = -.18$, $p < .01$) and 4+ days ($r = -.39$, $p < .001$), Model 5 was re-ran using only one of these indicators at a time. In both cases, spring internet quality was still the only technology access variable that significantly predicted spring GPA.

used to test H1b, moving back home did not appear to be a unique predictor of spring GPA. The analysis used to test H1b was then repeated with the inclusion of interaction terms between the variable representing whether students moved home and each of the technology access variables. There were no significant interaction effects between the spring PC or internet quality and moving back home on GPA. However, there was a significant interaction effect between having no access to one's PC for at least four days and moving home, ß = 1.04, $p$ = .05. To explore this interaction further, the dataset was split into a subset of those who moved back home ($n$ = 153) and another subset of those who did not ($n$ = 120). After controlling for covariates, having no access to one's PC for at least four days was a significant predictor of spring GPA among those who did not move home (ß = -1.28, $p$ = .006), but this was not the case among those who did end up moving home (ß = -0.17, $p$ = .64).

### 3.3. Technology Access, Stress & Coping

*Perceived Stress in Spring 2020.* Hypothesis 2 predicted that lower quality access to technology was associated with greater perceived stress during the early months of the COVID-19 pandemic after controlling for demographic factors. This hypothesis was tested using a hierarchical linear regression analysis. In model 1, covariates alone explained 12.4% of variance in perceived stress among students, $F$(202) = 2.40, $p$ = .01. Spring internet quality was added in model 2 and was a marginally significant predictor of perceived stress, ß = -0.13, $p$ = .06. In model 3, spring internet quality was replaced with PC quality, which was a significant predictor of perceived stress, ß = -0.19, $p$ = .01. In model 4, PC quality was replaced with two dummy variables indicated whether students were without a PC for 1-3 days or at least 4 days during the spring quarter. Going without a PC for 1-3 days was not a significant predictor of stress (ß = 0.21, $p$ = .31), but going without it for 4 or more days was (ß = .49, $p$ = .04). Lastly, all the predictors related to spring technology access were entered simultaneously in model 5. Only spring internet quality was a significant predictor of perceived stress in this model, ß = .18, $p$ = .02. Interestingly, only model 3 explained a significantly greater proportion of variance in perceived stress compared to model 1 ($F$ of $\Delta R^2$ = 7.17, $p$ = .01), although models 2 and 5 each explained a nearly significantly greater proportion of variance relate to model 1 ($p$ = .06 for both models). These results partially support H2 (see Table 5).

*Perceived Ability to Cope with Stress in Spring 2020.* Next, H3 predicted that lower quality access to technology was associated with a reduced capacity to cope with stress in the early months of the pandemic after controlling for demographic factors. Another hierarchical linear regression analysis was used to test this hypothesis. In model 1, covariates alone explained only 8.3% of variance in perceived coping, $F$(200) = 1.50, $p$ = .13. Spring 2020 internet quality was added in model 2, and this variable was a significant unique predictor of perceived coping, ß = .25, $p$ < .001. Spring internet quality was replaced with PC quality in model 3, and this model explained 14.5% of the variance, $F$(199) = 2.56, $p$ = .002. PC quality was also a significant predictor of perceived coping, ß = .17, $p$ = .01. In model 4, PC quality was replaced with two dummy variables indicated whether a student's PC was inaccessible for 1-3 days or at least 4 days. Neither of these variables was a significant predictor of coping. Finally, in model 5, all the technology access variables were entered simultaneously. Only internet quality was a significant predictor of perceived coping, ß = .23, $p$ = .002. Models 2, 3, and 5 explained significant proportions of variance independently and significantly greater proportions of variance compared to model 1 ($p$ < .05), although model 4 did not. These results mostly support H3 (see Table 6).

## 4. Discussion

While access to digital technologies has increased in recent years, the pandemic dramatically changed how students interact with these technologies. These changes were made particularly evident when comparing the online experience of students shortly before and after the pandemic. Findings reexamine the role of institutions in expanding access to technology while extending the technology maintenance and dependable instability constructs to a novel social context in which digital communication became the foremost means of all academic communication.

In this study we assessed the effects of dependable instability on students before and a few weeks after the start of online instruction. In doing so, we ultimately sought to observe the relationships between the quality of one's internet connection or PC access and students' academic performance, perceived stress, and perceived coping. In addition to testing whether students' residence moderated the effect on GPA, we also contribute to the digital divide literature by testing the effects of digital inequality on stress and coping.

First, to our surprise we found that neither the quality of internet nor PC access were significant predictors of GPA during the winter quarter before the pandemic lockdown began (**H1a**). This null result stands in contrast with previous research documenting the relationship between computing quality and grades (Gonzales et al., 2020; Reisdorf et al., 2020). In the

spring quarter, however, the quality of one's PC and being without a PC for at least four days was associated with GPA (**H1b**). This is not surprising given that technology that was already important became even more essential once all coursework was moved online during lockdown. This is consistent with findings from other researchers using student samples from different universities within the U.S. (Jaggars et al., 2021; Katz et al., 2021), and elaborates on those findings by assessing the effects of digital access on GPA specifically, rather than students' self-reported remote learning proficiency (Katz et al., 2021) or perceived academic success (Jaggars et al., 2021) during the pandemic.

To better understand the effects of computing quality on GPA during the early weeks of the pandemic we also explored whether moving home from campus moderated the relationship between quality of access to technology and GPA (**RQ1**). We did not make a directional prediction in this case, given benefits and costs to leaving campus. However, our analysis revealed that, for those who were without their PC for four days or more during spring quarter, there was a negative association with GPA for those who remained on campus but not for those who moved home with their families, after controlling for other demographic variables. These findings underscore the fact that campuses are a source of tech resources for disadvantaged students during the regular academic year (Gonzales et al., 2020; Reisdorf et al., 2020), but those resources were suddenly unavailable.

Our second set of hypotheses assessed the effects of technology access on students' mental health (specifically perceived stress and coping) during the early months of the pandemic (**H2** & **H3**). Previous research had identified relationships between people's use of technology and their mental health during this period (Eden et al., 2020; Nabi et al., 2022; Pahayahay & Khalili-Mahani, 2021), but the effects of technology maintenance issues on people's perceived stress and coping had been unexplored. First, we found that PC quality and going without a PC for four or more days were significant predictors of perceived stress, and that internet quality had a marginal effect on perceived stress (**H2**). This makes sense given that technology access and maintenance issues can be stressful themselves (Gonzales et al., 2020; Robinson, 2009). Additionally, we found that both internet and PC quality were significant predictors of perceived coping success (**H3**). People regularly use media to manage stress (Nabi et al., 2017), and lacking access to quality digital technology may inhibit this. Our study is the first, to our knowledge, to connect technology maintenance issues with one's ability to cope with stress. Future research is needed to elucidate the specific mechanisms by which the quality of one's PC and internet connection affect one's stress and coping.

### 4.1. Limitations

In interpreting the findings of this study, it is important to bear in mind its limitations. While the initial aim of the study was to understand students' experiences with digital disruption and technology repair, due to the sudden onset of COVID, it evolved into a study aimed at identifying students' ability to satisfy their basic psychological and technological needs during the pandemic. Although students' quarterly GPAs from winter and spring were provided by the institution, the other outcome variables (i.e., perceived stress and coping) were not included in the first survey and were introduced in the second survey in light of the circumstances. Therefore, we cannot assess whether the relationships between technology access and these outcomes changed from before and after the pandemic. Additionally, many of our measures relied on self-reported data from the participants. Self-report measures are subject to response biases such as memory recall issues which may impact the accuracy of the data. Another important caveat was the lack of data on the financial standing of students' households (though we did include parental education). This factor might account for some of the relationships found in this study. We should also note that in the first survey, we asked students to report whether their PC had ever been inaccessible or unusable in the past and for how many days, whereas in the second survey, we asked about this experience specifically during the spring 2020 quarter. As a result, we did not include this variable in the models examining the effects of technology maintenance variables on winter 2020 GPA. Nevertheless, the measure of PC quality in the first survey did ask students about their current computers. Moreover, internet access during the winter of 2020 was assessed retroactively in the second survey, thus limiting its validity. Lastly, in terms of sampling, the overrepresentation of female students should be kept in mind when interpreting the results.

## 5. Conclusion

The COVID-19 pandemic dramatically increased reliance on communication and information technologies on college campuses. As social distancing efforts led students to move from lecture halls to computer screens, the quality, functionality, and stability of these devices became critical. Literature surrounding the importance of stable device access points to the implications for outcomes such as

academic performance and stress (Gonzales et al., 2020; Katz et al., 1973; Cohen & Willis, 1985; King et al., 2013). Not surprisingly, findings suggest that pandemic-induced technology dependency may only have exacerbated the effects of digital instability on academics. This was especially true for students who remained on campus during the lockdown, where they no longer had access to the myriad technological resources previously available to them, and they had limited access to spare devices or people they could share technology with, given social isolation mandates. This finding reiterates the benefits of institutions like universities and other community organizations to supplement access to vital technology such as laptops for the individuals they serve.

These findings have significant practical implications for administrators, faculty, and students at institutions of higher education. Citing the unequal learning conditions created by the pandemic, some universities including Harvard opted to do away with grades for the spring 2020 semester and instead implement a satisfactory-unsatisfactory grading system. This research provides additional evidence to support that decision and helps students who did not benefit from such a policy justify declines in their GPAs during lockdown.

However, these findings also underscore the fact that universities' efforts to help students navigate COVID-19 should not cease now that there is no longer a state of emergency. Temporarily lacking access to technology had significant effects on the academic success and mental health of many university students. Future research should continue to assess the relationships between students' technology access and quality of life as technology has become a permanent and essential fixture in higher education.

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