Student Satisfaction with Broadband in Higher Education: A Survey Analysis

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Received: August 12, 2025 Accepted: November 23, 2025 Online Published: December 2, 2025

doi:10.5430/ijhe.v14n6p30 URL: https://doi.org/10.5430/ijhe.v14n6p30

Abstract

The COVID-19 pandemic and broader digital transformation have reshaped higher education, challenging institutions to adapt instructional models and address disparities in technology access. These changes may have lasting implications for learning outcomes, particularly among students in at-risk counties and among nontraditional student populations.

This study uses primary survey data to examine student satisfaction with broadband access, comparing traditional and nontraditional students. Key variables include demographic background, student status (e.g., first-generation, full-time enrollment, employment), and subjective learning experiences. Both qualitative responses and a logistic regression model were analyzed to identify predictors of satisfaction.

Qualitative findings indicate that satisfaction with broadband varies by student characteristics. For example, the impact of being a full-time student without a job differs between traditional and nontraditional students. Conversely, being a non-first-generation student shows a consistent positive association with satisfaction across both groups. The quantitative model finds that students reporting a positive online learning experience are significantly more likely to be satisfied with broadband. However, no statistically significant difference in overall broadband satisfaction was found between traditional and nontraditional students.

These findings suggest shifting expectations and nuanced influences on technology satisfaction. As institutions increasingly rely on digital tools, understanding how different student populations perceive and access technology is critical. In particular, institutions must ensure that students in at-risk counties and those with nontraditional profiles are not left behind in a rapidly evolving learning environment.

Keywords: broadband, traditional nontraditional students, higher education, digital equity

1. Introduction

The COVID-19 pandemic of 2020 required many universities, including the host institution for this study, to transition rapidly from in-person to online instruction. This abrupt shift, combined with growing disparities in broadband access across the United States, imposed new challenges in accessing higher education for students with different backgrounds. Approximately 18.9% of the U.S. population resides in economically "at risk" counties ("Distressed Communities Index," n.d.), where broadband service is often limited or unreliable. These regions face heightened vulnerability to business cycle fluctuations and technology disruptions. The pandemic underscored certain inequities within broadband infrastructure—often referred to as the digital divide—which disproportionately affects students living in rural or distressed counties (Rainie 2021; Early and Hernandez 2021).

This study investigates how satisfaction with broadband access differs across traditional and nontraditional students, with a particular focus on those residing in "at risk" counties in Tennessee, during the COVID-19 pandemic. Using survey data collected during a period of large-scale, remote instruction, this paper examines student perceptions of broadband accessibility, online learning experiences, and related technological factors. Relatively little research has focused on how broadband access influences learning, particularly among students living in technologically disadvantaged or economically distressed regions (Sutherland et al. 2024). In addition, the paper explores whether

institutional efforts—such as providing mobile hotspot and wi-fi devices—help mitigate disparities in educational access.

The findings point to the critical role of reliable broadband in supporting student engagement and satisfaction with online learning. As higher education increasingly relies on remote education, understanding how nontraditional and traditional students differ in how they access and use technology remains vital for designing equitable learning environments. By increasing the focus on students in "at risk" counties, this study contributes to the broader literature on equitable learning environments and provides practical insights for policymakers to strengthen educational access and outcomes.

2. Past Research

Over time, instructors face challenges associated with integrating technology into traditional classroom settings. Aubusson et al. (2014) recognize these challenges in the classroom as they relate the balance of technology with traditional instruction. The authors employ a discrete choice model to forecast how task attributes influence four levels of student perception (Aubusson et al. 2014). The authors stress the need to understand the interactions between a teacher's individual approach and the technologies that are introduced (Aubusson et al. 2014).

Aquino and Bushell (2020) emphasize the coupling of such factors as aligning the correct technology to the student's ability in attaining student success. Tamin et al. (2011) identify technology as favorable to conventional teaching to achieve student outcomes.

Regarding student perceptions, Draude and Brace (1999) use a survey approach and find technology favorable to promote learning, student engagement, and targeted learning. The findings of Ham (2005) suggest that student success depends on the attributes of the online vehicle, which include "self-efficacy," adaptability to technology, instructor involvement, and technology assistance. On the other hand, Chowdhry et al. (2014) report that "virtual learning environments" did not have an influence on student performance, as measured by overall course grades. The authors recommend further investigation into these technologies to enhance student learning.

Technology in learning may impact student demographics differently. The work of Cherrstrom et al. (2019) examine how perceptions of technology in education differ across nontraditional and traditional student groups. The authors emphasize the role that "multiple domains" apply to the nontraditional student.

Tobin (2021) cites the use of mobile devices in teaching nontraditional students. A list of criteria is outlined in this research, and the literature advises that faculty strive for "the broadest possible audience of learners."

Adult learning is also explored in the work of Abedini et al. (2021). The authors identify engagement as beneficial to improve adult learning, where such factors as quality of life and hesitancy to adopt technology may play a role in the level of engagement.

Woods and Frogge (2017) study technology perceptions for traditional versus nontraditional students. Findings indicate increased levels of study and work time for nontraditional students.

Arribathi et al. (2021) investigate the impact of the Covid-19 pandemic on anxiety in higher education. The authors report that anxiety during this period emanates from several areas, including "learning motivations" and sudden changes in learning methods. This work suggests that practical and effective technologies may offset these problems in both traditional and unorthodox learning settings.

The next section explains the methods taken in the paper to identify trends in student satisfaction with broadband. The survey methods are detailed and a quantitative model is introduced that estimates the likelihood of satisfaction with broadband access, given key factors of influence.

3. Materials and Methods

In this section, a review of the methods on the survey tables and regression is provided. A background on the survey instrument and its implementation is also discussed.

This study was conducted during the 2020 pandemic, a period when universities transitioned to online and remote learning methods. University students residing in "at risk" counties in Tennessee were randomly provided with mobile hotspot / wi-fi devices. This technology aimed to serve as an effective substitute for broadband access, thereby reducing disparities in educational access. Over the span of two academic semesters, the authors distributed a Qualtrics survey to university students living in distressed or "at risk" counties in Tennessee to assess the effectiveness of the hotspot and wi-fi devices.

The survey instrument included various questions on the demographics of students, their level of satisfaction with broadband access, their experiences with the hotspot devices, etc. The methods did not include face-to-face interviews with the subjects.

Throughout this study period, there were 986 surveys distributed to students across campus, and 147 responses were collected. This equates to a response rate of 14.91%.

Descriptive statistics for select responses of the survey are presented and discussed in the Results section. The survey results are also used to develop a quantitative model to test for a difference in broadband satisfaction between traditional versus nontraditional students, among other tests. To ensure accuracy and reliability, the survey tables in the Results section reference the counts used for each table (provided in the Endnotes). Missing observations are documented to indicate adjustments to the sample size for each table. In the next paragraphs, the methods of the quantitative model are discussed.

As part of the quantitative portion of this paper, a logistic regression was employed to determine which factors were important to predict the probability of satisfaction. The choice of the logistic regression over a linear probability model is based on many factors, with the primary factor being related to the binary nature of the dependent variable.

The dependent variable outcome is binary that takes on the numerical value of 1 for subjects indicating Very Satisfied or Satisfied for the survey Question 32 that reads "Please rate your satisfaction with internet/broadband access in the county you currently reside." The variable outcome equals 0 for subjects indicating Dissatisfied, Very Dissatisfied, or Neutral. Thus, the estimated sample regression coefficients will indicate the change in the "log odds ratio," with respect to the independent variable of interest, for predicting outcomes equal to 1, holding the other independent variables constant.

While Ordinary Least Squares (OLS) does reasonably well to predict outcomes with binary dependent variables, it can predict probabilities above 1 and below 0, rendering the technique problematic. An alternative specification is the logistic function,

$$f(w) = \frac{e^w}{e^w+1} = \frac{1}{1+e^{-w}} \text{ Eq. 3.1} \quad (1)$$

and is constrained to fall between 0 and 1 (Hilmer and Hilmer 2014). A unique attribute of the logistic regression is the estimation of sample regression coefficients that are "log odds ratios." And although these provide useful statistical outcomes, they can present challenges with interpretation. An adjustment is to estimate the marginal effects using "odds ratios." This approach will be emphasized in the Results section.

The specification for the logistic sample regression function, which predicts the likelihood of being satisfied with broadband access, is as follows:

$$\begin{aligned} \text{outcome}_i = {} & b_1 + b_2\text{metroarea}_i + b_3\text{lifestatus}_i + b_4\text{medium}_i + b_5\text{high}_i + b_6\text{COB}_i + b_7\text{Arts}_i + b_8\text{undergrad}_i + \\ & b_9\text{sophmore}_i + b_{10}\text{junior}_i + b_{11}\text{senior}_i + b_{12}\text{fulltime}_i + b_{13}\text{pleasant\_online}_i + b_{14}\text{hours}_i + b_{15}\text{tools}_i + \\ & b_{16}\text{summer}_i + b_{17}\text{device}_i + b_{18}\text{traditional}_i + e_i \text{ Eq. 1} \end{aligned} \quad (2)$$

The independent variables are a mix of qualitative and quantitative variables that serve as controls for demographics, academic standing and measures of structural change. A description of the variables is presented in Table 1. For the purposes of this paper, a student who reported an age of greater than 25 years old was classified as nontraditional. Overall, the data set consisted of 95 students classified as traditional and 52 as nontraditional.

3.1 Variable Descriptions

Table 1. Description of Variables

Variable Name	Description
Metro	Dummy variable that takes the value of 1 if students reside in Putnam County, which is considered unofficially metropolitan relative to surrounding counties in the sample.
Life Status	Dummy variable that takes the value of 1 if the student is married.
Low Income	Dummy variable that takes the value of 1 if the student's income is $0 - 9,999 based on the survey question: “Which of the following describes your personal income last year?”
Medium Income	Dummy variable that takes the value of 1 if the student's income is $10,000 - 34,999 based on the survey question: “Which of the following describes your personal income last year?”
High Income	Dummy variable that takes the value of 1 if the student's income is $35,000 - 49,999 based on the survey question: “Which of the following describes your personal income last year?”
College of Business	Dummy variable that takes the value of 1 for a specific college within the university.
Arts	Dummy variable that takes the value of 1 for a specific college within the university.
College Other	Dummy variable that takes the value of 1 for a specific college within the university (omitted category in the regression).
Full-Time	Dummy variable that takes the value of 1 if a student is full-time, based on the survey question: “Which best describes you? Part-time or full-time student.”
Part-Time	Dummy variable that takes the value of 1 if a student is part-time, based on the survey question: “Which best describes you? Part-time or full-time student.” (omitted category in the regression)
Pleasant Online	Dummy variable that takes the value of 1 if a student reported a pleasant online learning experience, based on the survey question: “What is your feeling regarding taking online classes?”
Unpleasant Online	Dummy variable that takes the value of 1 if a student reported an unpleasant online learning experience, based on the survey question: “What is your feeling regarding taking online classes?” (omitted category in the regression)
Hours	Number of registered credit hours for a given respondent.
Tools	Measures the association between technological infrastructure and broadband satisfaction, based on the survey question: “Which computer set-up best describes your situation?”
Summer	Dummy variable that takes the value of 1 if a student plans to take summer courses, based on the survey question: “Will you take summer courses?”
Device	Measures the effect of receiving a free wi-fi device on broadband satisfaction.
Traditional	Dummy variable that takes the value of 1 for traditional students, defined as students who are 25 years old or younger.
Nontraditional	Dummy variable that takes the value of 1 for nontraditional students, defined as students who are 26 years old or older (omitted category in the regression).

4. Results

The survey results reveal heterogeneity in contributing factors for each student group, traditional and nontraditional. For instance, conditional on not the first to attend college, a higher percentage of nontraditional students were satisfied with their broadband (71.34% vs. 57.14%). Alternatively, of those students fulltime with no job, traditional students reported a higher satisfaction with broadband (76.92% vs 69.23). Furthermore, the results of the quantitative model reveal no significant difference in the probability of broadband satisfaction across traditional versus

nontraditional students. However, when the student groups are pooled, there is a significant, positive association between a student's pleasant, online experience and degree of satisfaction.

A noteworthy observation is the following: when the data is pooled, participants who received a wi-fi device as part of the grant were expected to realize improvements in their broadband satisfaction. However, it is important to note that improvements do not invariably result in heightened satisfaction. This observation is supported by the findings in the model. Contrary to initial expectations, the coefficient associated with the variable "device" displays a negative, albeit statistically insignificant, value. This result indicates that satisfaction with broadband falls for those who adopted a wi-fi device. In the following section, a qualitative analysis is presented on the results from the survey tables.

4.1 Survey Tables

Table 2. Overall by Student Group

Classification	Count	Percent
Nontraditional	52	35.37
Traditional	95	64.63

An overall comparison of traditional to nontraditional students indicates that for the 147 subjects in the sample, traditional students had a 64.63% representation and nontraditional had a 35.37% representation (Table 2: Overall by Student Group). (The distinction between the student groups is made using an age-criteria.) In the sections that follow, select comparisons between the groups are discussed using conditional calculations as the backdrop.

Table 3. Outcome by Student Group

Classification	Not Satisfied	Satisfied	Total
Nontraditional	9	37	46
Traditional	33	54	87

When cross-referencing student group (nontraditional vs traditional) with outcome (satisfied versus not satisfied with broadband), conditional calculations reveal noteworthy trends in the data (Table 3: Outcome by Student Group). Of the nontraditional students, 80.43% reported satisfaction with their broadband (37/46). Of traditional, 62.07% were satisfied (57/87). These observational differences may be due to variation in broadband access and quality of infrastructure between the student groups, possibly attributable to generational differences.

Table 4. First to Attend: Traditional

Outcome	No	Yes	Total
Not Satisfied	27	6	33
Satisfied	36	18	54
Total	63	24	87

Table 5. First to Attend: Nontraditional

Outcome	No	Yes	Total
Not Satisfied	8	1	9
Satisfied	20	17	37
Total	28	18	46

Table 4 cross-tabulates satisfaction with broadband with first to attend college for 87 traditional students (95 total traditional students, 8 missing observations). For traditional students, of those that were first to attend, 75.00% were satisfied with their broadband ([18/24] *100). Of those that were not the first to attend, 57.14% were satisfied with their broadband ([36/63] *100).

Table 5 cross-tabulates satisfaction with broadband with first to attend college for 48 nontraditional students (52 total, 6 missing observations). For nontraditional students, of those that were first to attend, 94.44% were satisfied with their broadband. Of those that were not the first to attend, 71.43% were satisfied with their broadband.

When analyzing the in-group comparisons further, some observational consistencies can be observed. When the groups are pooled together, the satisfaction rating for the conditional interpretation was lower for not the first to attend (compared to first to attend). A possible explanation may be that if the subject was not the first to attend college, then a family member likely attended in a prior time period. As a result, the subject may have obtained higher expectations of quality broadband access, thus potentially leading to a lower satisfaction rating.

Table 6. Status: Traditional

Outcome	Full-time student, full-time job	Full-time student, part-time job	Full-time student, no job	Part-time student, full-time job	Total
Not Satisfied	10	15	6	2	33
Satisfied	7	27	20	0	54
Total	17	42	26	2	87

Table 7. Status: Nontraditional

Outcome	Full-time student, full-time job	Full-time student, part-time job	Full-time student, no job	Part-time student, full-time job	Part-time student, part-time job	Part-time student, no job	Total
Not Satisfied	1	0	4	3	1	0	9
Satisfied	9	5	9	10	2	2	37
Total	10	5	13	13	3	2	46

Table 6 cross-tabulates satisfaction with broadband with student status for 87 traditional students (95 total, 8 missing observations). Of those that were full-time with no job, 76.92% were satisfied with their broadband. Of those that were full-time with a part-time job, 64.29% were satisfied with their broadband.

Table 7 cross-tabulates satisfaction with broadband with fulltime status for 46 nontraditional students (52 total, 6 missing observations). For nontraditional, of those that were full-time with no job, 69.23% were satisfied.

When analyzing Table 6 for traditional students, it may be worthwhile to emphasize the following: the higher rating (76.92%) for full-time with no job may be attributed to this group exhibiting a lower opportunity cost, as measured by foregone wages. This group, compared to full-time with a part-time job, may have therefore achieved a comparative advantage in technology, possibly explaining the higher satisfaction rating comparably (76.92% vs 64.29).

This same dynamic may not be applicable to nontraditional students (Table 7): for the group who is full-time with no job, we get a lower satisfaction rating when compared to nontraditional with a part time job (69.23% vs 100%). There is likely a different dynamic taking place: perhaps the nontraditional student, even if exclusively fulltime, has higher expectations with broadband based on more experience in the workforce. If these expectations are not being met in the academic setting, then this could explain the lower satisfaction rating (Note 1).

Table 8. Living Arrangement: Traditional

Outcome	Live off-campus	Live on-campus	Total
Not Satisfied	32	1	33
Satisfied	46	8	54
Total	78	9	87

Table 9. Living Arrangement: Nontraditional

Outcome	Live off-campus	Live on-campus	Total
Not Satisfied	9	0	9
Satisfied	37	0	37
Total	46	0	46

Table 8 cross-tabulates satisfaction with broadband with living arrangement for 87 traditional students (95 total, 8 missing observations). Of those that live off-campus, 58.97% were satisfied with their broadband.

Table 9 cross-tabulates satisfaction with broadband with living arrangement for 46 nontraditional students (6 missing, 52 total, 6 missing observations). The survey indicates that 100% of the nontraditional students live off-campus. Of this group, 80.43% were satisfied with their broadband ([37/46] *100).

Across both groups, traditional and nontraditional, the majority live off-campus. But when within-group comparisons are made, if living off-campus, a lower share of traditional were satisfied with their broadband than for their nontraditional counterparts (58.97% vs 80.43%). This outcome may indicate that traditional students living off-campus face greater challenges in their broadband access than traditional students living on-campus. This could be due to an increased level of variation in broadband quality in households that may be missing within on-campus environments.

Table 10. Life Status: Traditional

Outcome	Divorced	Married	Single/Never Married	Total
Not Satisfied	0	2	30	32
Satisfied	1	1	44	46
Total	1	3	74	78

Table 11. Life Status: Nontraditional

Outcome	Divorced	Married	Single/Never Married	Total
Not Satisfied	0	5	4	9
Satisfied	5	23	9	37
Total	5	28	13	46

Among nontraditional students, 60.87% were married while 28.26% were single/never married (Tables 10 and 11) (For the variable life status). For the traditional students, 3.85% were married, while 94.87% were single/never married.

Table 10 cross-tabulates broadband satisfaction with marital status for 78 traditional students (95 total, 17 missing observations). For traditional students only, of those that are single/never married, 59.46% were satisfied with their broadband ([(44/74) *100]).

Table 11 cross-tabulates broadband satisfaction with marital status for 46 nontraditional students (52 total, 6 missing observations). For nontraditional students only, of those that are single/never married, 69.23% were satisfied with their broadband. Of those that are married, 82.14% were satisfied.

There is a stark contrast between the groups regarding marital status: a disproportionate share of nontraditional students identified as married. Additionally, when accounting for single/never married, the proportion satisfied with their broadband appears observationally similar across traditional versus nontraditional (59.46% vs 69.23%). And although it is difficult to identify an intuitive explanation for these results, the high share of married, nontraditional respondents is consistent and within expectations.

4.2 Quantitative Model

To better understand student satisfaction with broadband access, a quantitative model is generated using demographic data and survey results. Specifically, a logistic regression is employed to identify the factors most influential in predicting the change in probability of being satisfied with broadband (Table 12). Additional details are provided in the Methods section on this estimation technique and model specification.

Table 12. Model Results, Logistic Regression Results

Parameter	Estimate	Standard Error	Wald Chi-Square	P-value
Intercept	.1609	1.7199	.0088	.9254
Metro	.0571	.2886	.0392	.8431
Life Status	-.1326	.5402	.0603	.8061
Medium Income	.3365	.6334	.2823	.5952
High Income	-.6938	1.2831	.2924	.5887
College Business	-.1743	.8280	.0443	.8333
College Arts	.8123	.7314	1.2337	.2667
Undergraduate	-.8085	1.1604	.4854	.4860
Sophomore	1.1823	1.0280	1.3228	.2501
Junior	-.0174	.9119	.0004	.9848
Senior	-.1712	.8745	.0383	.8448
Full	-.5749	.5817	.9770	.3229
Pleasant Online	1.4501	.5699	6.4736	.0109
Hours	.1142	.1025	1.2419	.2651
Tools	.8620	.5379	2.5681	.1090
Summer	-.0631	.6243	.0102	.9195
Device	-1.0736	.9148	1.3772	.2406
Traditional	-1.3822	1.2329	1.2567	.2623

The statistical insignificance of the variable traditional indicates a lack of a difference in the probability of satisfaction with broadband access across traditional versus nontraditional students (Table 12) (Note 2).

It is worthwhile emphasizing that despite this result, the negative sign on traditional indicates that the likelihood of being satisfied with broadband access falls for traditional students when compared with nontraditional (the omitted group). This result seems consistent with the observations from Table 3: Outcome by Student Group, where a larger share of nontraditional students reported satisfaction.

The results discussed above may suggest cultural differences in how the groups view technology in higher learning. Further, despite the insignificance referenced above, the survey tables highlight observational differences across the student groups that still warrant attention in the overall analysis.

The variable pleasant_online reports as positive and statistically significant at conventional alpha levels (Table 12). When the student groups are pooled, those reporting a pleasant, online experience associate with an increased likelihood of being satisfied with broadband. This outcome is somewhat expected, and is consistent with those having favorable, online experiences also harboring high-quality, broadband technologies.

This result raises additional questions: “Is good broadband encouraging a pleasant broadband experience?” Or is the direction of influence reversed? Ultimately, the answers to these questions may remain unknown. But it is likely that the direction of influence, in varying degrees, is going both ways.

The variable tools, which predicts satisfaction for those using a “laptop” or “laptop, mobile phone,” generates a positive, but insignificant coefficient. This suggests that the likelihood of satisfaction rises for those using these devices (compared with those using a desktop to complement their other devices, for instance). It may be the case that students who rely on mobile devices exclusively may associate with improved broadband arrangements and thus exhibit a greater degree of satisfaction.

Another variable of interest in the model is credit hours. The model indicates that students (pooled traditional and nontraditional) registered for more credit hours associate with an increased likelihood of being satisfied with internet access within their county. This result may be attributable to experience, whereas students who take more classes also invest in the relevant technology that advances their cause. This outcome is somewhat expected and supports the idea that those who take disproportionally more online classes may self-motivate to maintain high-quality broadband.

The reader should observe this result with caution: it may indicate some degree of self-selection bias, whereby the survey is picking up individuals who may default to high-quality internet access because they are disproportionally engaged in online learning.

As mentioned in an earlier section, this study was prompted by a grant entitled "Bridging the Digital Divide through Hotspots," which addresses the impact of technology in underserved areas in higher education. As part of the grant, students residing in "at risk" counties were offered a free wi-fi device to access online classes. The intent of this device was to provide alternative internet access to reduce disparities in broadband quality. Survey responses were collected for students who adopted devices and for those that did not.

In the quantitative model, the variable device measures the difference in the likelihood of satisfaction between those that used the device versus those that did not. The variable device reports as negative, but insignificant. The sign suggests, however, that the likelihood of being satisfied with broadband access falls for those adopting wi-fi devices. Intuitively, this group may not have fully realized the impact of the wi-fi device by the time they filled out a survey. As a result, any potential increased level of satisfaction attributable to the device may have required more time to translate to the survey.

5. Discussion

The objectives of this paper were to 1) identify whether student satisfaction with access to broadband technology in academia differed across traditional and nontraditional students, and 2) determine if a free wi-fi device improved the broadband experience for students in at-risk counties.

Relevant research explores the experiences of traditional versus nontraditional students in higher education (Cherrstrom et al. 2019; Woods and Frogge 2017, Ham 2005, Aquino and BuShell 2020). Cherrstrom et al. call for an added focus on the nontraditional learner's experiences with technology, and differentiating this from the expectations of traditional students. Our paper's contributions add to this collection of research by extending the focus on student groups living in "digital deserts."

The survey findings of Woods and Frogge identify increased levels of study and work time for nontraditional students. Our paper extends this area of study by a) employing a survey instrument to measure demographic and descriptive measures across those student groups, b) surveying students that reside in "at risk" counties, c) focusing on satisfaction with broadband access across student groups, and d) isolating the effect of satisfaction with technology using a quantitative model.

The survey tables presented mixed results. When focus was placed on the conditional probability of those who were not the first to attend college, a higher percentage of nontraditional students were satisfied with their broadband (71.34% vs 57.14%). On the other hand, of those fulltime students with no job, traditional students reported a higher satisfaction with broadband (76.92% vs 69.23%).

Although it is difficult to identify a single, underlying trend, the descriptive statistics provide some insight into each group's outlook on technology. Traditional and nontraditional students likely harbor different household dynamics and generational influences as it relates to higher learning. These factors, along with others aforementioned in previous sections, may therefore play a role in how each group views access to broadband.

The quantitative model did not show a significant difference in the probability of satisfaction with broadband across traditional versus nontraditional students. Future research may reveal, however, whether differences exist when these groups are interacted with other demographic measures.

When the groups are pooled together, there was a significant, positive association between a student's "pleasant, online experience" and the degree of satisfaction (This result was for all students, and therefore not a comparison between traditional versus nontraditional.). This outcome is consistent with expectations. It can be argued that for both traditional and nontraditional students, having positive, online engagement is likely to be linked to satisfaction with broadband technologies. Further research into this result may shed light of the direction of influence. But it is likely that these attributes influence each other in varying direction and degrees.

Another focus of this paper was to determine if students residing in "at risk" counties saw improvement in their technology access from a wi-fi device. The quantitative model did not provide evidence for this. However, the sign on the variable device was negative, which was counter-intuitive to expectations. This suggests that the likelihood of satisfaction with broadband falls for those that adopted a device (compared to those that did not). Although there was an attempt to explain this result in the Results section, more attention is needed here to understand the dynamics behind the wi-fi device.

As new technologies are introduced in higher education, upholding standards of learning for all student groups should be a primary goal. The survey results in this paper highlight potential differences in the satisfaction with broadband access across traditional versus nontraditional groups. Such variation can be observed in relation to second-generation students and exclusively full-time students. In general, these trends may be explained by shifts in cultural norms in technology. Other factors playing a role include the ability of certain student groups to attain a comparative advantage in technology and the expectations set by households with family in college.

In summary, our paper highlights key factors influencing satisfaction with broadband across critical student classifications. Attaining knowledge of how nontraditional students deal with technology access differently than their traditional counterparts can assist academic institutions to improve learning. In a world of changing technology, the desire of students to achieve higher education should be accommodated and monitored for accessibility with the highest of standards.

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Notes

Note 1. Compared to the 100%, or all 5 of the part time job rating satisfied. Caution: for nontraditional students, only 13 (28.26%) reported "full time with no job." This is to be expected, since most nontraditional student will likely work full or parttime.

Note 2. The partial regression coefficient reflects the condition when the subject is classified as traditional (the omitted category is 0 if nontraditional and serves as the baseline in the intercept of the model). Reported p-value = .2623

Appendix

Declaration of Interest Statement

'The author(s) declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article'.

Author Contributions Statement and Ethics

An application for Research Involving Human Subjects was completed and approved. The relevant Ethics Committee or Institutional Review Board was the Institutional Review Board at [redacted] (TTU Policy 730). The co-investigators (and thus authors of this paper) completed the relevant human subjects training in "responsible conduct of research and ethics in human subject research" via CITI Training Modules, on January 9 2021.

Consent to Participate

The IRB reported (Step 11) that the "researchers will obtain written, informed consent from the participants." Participants were informed in the survey that in order to receive a hotspot device, as part of the grant initiative, they were providing their consent to participate.

The following language was used in the survey to the participants:

"[redacted], as part of a grant entitled The Great Divide, is conducting a survey to assess student accessibility to online learning formats. The questions in this survey are designed to measure the impressions and experiences of students regarding such factors as broadband performance and technological access.

Your responses are valuable and will help the university make progress towards its goal of improving learning outcomes for students. Your participation in this survey is very important and is a chance to have your experiences documented. The data from the survey could be used for conference presentations and/or publications. Individual responses will be anonymous.

Thank you for your participation."

Consent for Publication

This study did not contain any data from an individual person that would be considered personal in nature, and/or contain the ability to identify the individual in the data. The IRB reported (Step 10) that "No reported data included any private information (e.g. social security numbers, contact information) or identifying information (e.g., actual names, specific employers, specific job titles) of the participants." In addition, the survey language indicated that "individual responses will be anonymous."

The intent to publish was indicated to the respondents in the survey language, as indicated below.

The following language was used in the survey to the participants:

"[redacted], as part of a grant entitled The Great Divide, is conducting a survey to assess student accessibility to online learning formats. The questions in this survey are designed to measure the impressions and experiences of students regarding such factors as broadband performance and technological access.

Your responses are valuable and will help the university make progress towards its goal of improving learning outcomes for students. Your participation in this survey is very important and is a chance to have your experiences documented. The data from the survey could be used for conference presentations and/or publications. Individual responses will be anonymous.

Thank you for your participation."

Data Availability Statement

The authors would prefer not to upload the data into public data repository. And although there is no individual/personal/identifiable data, we did get consent to conduct research from participants, but not for public sharing.

Funding Statement

This work was supported by a grant entitled “Bridging the Digital Divide: Connecting Rural Students.”