Enhancing Digital Literacy in Higher Education: A Comprehensive Analysis of Digital Skill Development Among College Students

Trisha D. Anderson
Texas Wesleyan University

Gokcen Ogruk-Maz
Texas Wesleyan University

Thomas J. Bell, III
Texas Wesleyan University

This study investigates the development of digital skills among college students, examining their self-perception and the influence of various elements on their digital literacy. We surveyed 305 participants, and covered areas such as Information and Data Literacy, Communication and Collaboration Skills, Digital Content Creation, Digital Safety, and Technology Agility. Using paired t-tests and regression analysis, our study demonstrated significant improvements in digital skills compared to pre- and post-college education. A majority of participants recognized the importance of technology in education and regression analysis showed that higher education levels positively correlated with digital skill proficiency, and e-learning interactivity was essential in skill enhancement. Surprisingly, the COVID-19 pandemic did not significantly affect digital skill development. The findings highlight the crucial role of college education, particularly e-learning and course digital technology requirements, in advancing digital competencies, suggesting that factors beyond the pandemic are more influential in shaping digital skills.

Keywords: digital literacy, college education, workforce preparation, digital skills development, COVID-19 impact, educational technology

INTRODUCTION

In an era where digital technology permeates every aspect of life, acquiring and developing digital skills have become crucial, especially for college students preparing to enter a highly digitalized workforce (Hecker and Briggs 2021). As the world undergoes rapid technological advancements, the ability to adapt and excel in digital competencies is not just beneficial but essential for academic and professional success. This research paper delves into the dynamics of digital skill development among college students, comprehensively analyzing how their educational journey shapes their digital literacy.

The world is currently witnessing significant economic and social shifts, emphasizing the urgent need for well-educated human capital. These individuals must possess the ability to adapt to these rapid changes and address the complex challenges of the 21st century. Digital skills are increasingly recognized as crucial,

becoming the cornerstone of company competitiveness and innovation. As innovation largely depends on people, human capital is indispensable in shaping any organization's strategic direction and operational effectiveness. Emphasizing the importance of digital skills, it's clear that they are no longer optional but essential, empowering professionals to lead and excel in a fluctuating knowledge economy.

The digital skills encompassed in this study are broad and multifaceted, covering Information and Data Literacy, Communication and Collaboration Skills, Digital Content Creation, Digital Safety, Critical Thinking and Problem-Solving Skills, and Technology Agility (van Laar et. al., 2019). These areas represent the core competencies needed to navigate the complex digital landscapes of the modern education and the professional world. With the increasing integration of technology in educational settings, particularly heightened by the COVID-19 pandemic's impact on education systems worldwide, there is a pressing need to understand how these digital skills are being developed and mastered by students (Pokhrel and Chhetri, 2021; Yang and Huang, 2021).

Our research is grounded in the context of the drastic shift towards online and hybrid learning models instigated by the pandemic. This unprecedented transition has changed how education is delivered and raised questions about its effectiveness in imparting essential digital skills. While digital platforms have opened new avenues for learning, the extent to which they contribute to students' digital proficiency remains an area ripe for exploration.

To address this, we conducted an extensive survey with 305 college students, utilizing a mixed-methods approach to better understand their digital skill levels. This approach included the use of descriptive statistics to outline the demographic makeup and general tendencies of the student body, paired t-tests to examine changes in digital skills proficiency before and after college, and regression analysis to identify the key determinants influencing digital skill acquisition.

The significance of this study cannot be overstated in an era where digital literacy is as crucial as traditional academic skills. As the world evolves technologically, the gap between the digitally proficient and those lacking in these skills widens, potentially leading to disparities in employment, academic success, and societal participation (Robinson, 2015). This research, therefore, is not just an academic endeavor but a crucial step towards understanding and mitigating the digital divide. By evaluating the role of college education in developing digital competencies, our study contributes to the broader conversation about preparing students for a future where digital literacy is indispensable.

Our research is guided by several key questions that aim to shed light on the dynamics of digital skill acquisition in college students. Firstly, we ask, "How do students perceive their digital skills before and after their college education?" This question seeks to understand the subjective evaluation of digital competencies from the students' perspective. Secondly, we probe, "What are the significant determinants influencing the development of digital skills among college students?" Here, we aim to identify and analyze factors such as educational level, e-learning interactivity, and the impact of the COVID-19 pandemic. Finally, we question, "Does the college experience significantly enhance students' digital skills across various competencies?" This question is aimed at quantitatively measuring the impact of college education on students' digital literacy.

By addressing these questions, our study aims to provide empirical evidence and insights that could inform educational strategies, policy-making, and curriculum development. It seeks to contribute to equipping the next generation with the digital skills necessary to thrive in an increasingly digital world. This research is not just about understanding the current state of digital literacy among college students but also about paving the way for future educational reforms that prioritize the development of these essential skills.

LITERATURE REVIEW

In higher education, the development of students' digital skills has garnered significant attention in recent research. Studies have delved into various aspects of digital competence among students and educators, emphasizing the importance of integrating digital resources effectively into teaching practices to enhance learning outcomes (Falloon, 2020). Moreover, the impact of the COVID-19 pandemic has

underscored the necessity of ensuring that digital literacy and competencies are guaranteed in higher education settings, especially during challenging times like lockdowns (Tejedor et al., 2020). Perdana et al. (2019) focused on assessing students' digital literacy skills in senior high schools, emphasizing the need for a learning model to enhance these skills. Similarly, Alakrash & Razak (2021) explored technology-based language learning and the role of digital literacy, highlighting that participants exhibited high digital literacies. Moreover, Marty et al. (2013) investigated scientific inquiry, digital literacy, and mobile computing in informal learning environments, stressing the importance of fostering scientific inquiry practices and digital literacy skills among elementary students. Youssef et al. (2022) conducted a comprehensive study on ICT use, digital skills, and students' academic performance, revealing the intricate relationship between ICT investment, training, innovative use, and academic outcomes.

Research indicates a significant digital skills gap between the skills employers seek and the skills students possess. This gap has been exacerbated by rapid technological advancements that have increased the demand for digital skills in the workforce. Employers are increasingly looking for candidates proficient in data analysis, programming, digital marketing, and other technology-related skills (Cham et al., 2021). Surveys conducted by reputable organizations like the World Economic Forum and LinkedIn have consistently shown that employers struggle to find candidates with the necessary digital skills (Cham et al., 2021). On the other hand, educational institutions have faced challenges in adapting their curricula quickly enough to meet the evolving demands of the job market (Alenezi, 2021).

The International Telecommunication Union (ITU) and the United Nations (UN) have defined digital skills as the ability to use information and communication technologies effectively to achieve positive outcomes in various aspects of life. These skills are crucial for efficient task completion and adapting to evolving digital workflows (Reddy et al., 2020). Job descriptions across different industries often mention essential digital skills, which may vary slightly depending on the position's specific requirements (Cham et al., 2021). Indeed employment services outline fourteen essential digital skills in the contemporary workplace. These digital skills encompass a range of abilities related to technology, including software applications, digital devices, and computer hardware, that are crucial for efficient task completion and adapting to evolving digital workflows.

Studies have shown that the adoption of automation and AI technologies in the workplace will lead to shifts in the skills required of the workforce (Schlegel & Kraus, 2021). The demand for technological, social-emotional, IT, programming, and basic digital skills is expected to grow significantly across sectors such as banking, energy, healthcare, manufacturing, and retail (Schlegel & Kraus, 2021). These skills are often mentioned in job descriptions across various industries, but it's essential to note that the specific requirements may vary (Cedefop, 2018). However, essential digital skills for entry-level positions will vary slightly. These positions commonly require data entry, secure information processing, web-based research, web-based communication, email composition, virtual chat, video conferencing, cloud-based collaboration, word processing, computer literacy, and typing.

Bughin et al. (McKinsey Global Institute) study discusses how adopting automation and AI technologies in the workplace will lead to shifts in the skills required of the workforce. The authors conducted a survey and modeled skill shifts from 2016 to 2030, finding that the demand for technological skills and social-emotional skills will accelerate. Advanced technical skills, particularly IT and programming, are expected to grow significantly as well as basic digital skills. The authors discuss how different sectors, such as banking, energy, healthcare, manufacturing, and retail, will experience varying skill shifts.

Lastly addressing the digital skills gap requires a concerted effort from educational institutions, policymakers, and industry stakeholders. It is essential to focus on developing technical skills and soft skills like problem-solving and creativity to thrive in technology-driven environments (Obermayer-Kovács et al., 2022). Bridging this gap is crucial for the future success of industries and the overall economy.

DIGITAL SKILLS BACKGROUND, AND CONCEPTUALIZATION

In our comprehensive study, we explore a range of crucial digital skills essential for students' academic and professional advancement. These include Information and Data Literacy, Communication and Collaboration Skills, Digital Content Creation, Digital Safety, Critical Thinking, Problem-Solving abilities, and Technology Agility. Our study, grounded in the literature on Information and Data Literacy, emphasizes the pivotal role of information literacy in today's digital landscape. We prioritize assessing students' adeptness in navigating online information, encompassing tasks such as understanding search engine functionalities, evaluating search results, and critically analyzing online content for reliability and timeliness. The studies such as those by Diviani et al. (2015) and Metzger (2007) shed light on the evaluation of online information and credibility assessment, which are pertinent aspects of Information and Data Literacy. Deursen et al. (2015) contribute to the discussion by developing and validating scales related to internet skills, which are fundamental in assessing students' proficiency in online information retrieval. Additionally, research by Lucassen & Schraagen (2011) emphasizes the role of expertise in evaluating information credibility, a skill crucial for students navigating the digital landscape.

Understanding the significance of communication and collaboration skills in contemporary digital contexts is essential for our examination of students' proficiency in selecting appropriate communication tools, comprehending online behaviors across different settings, and collaborating in digital content creation. The literature offers valuable insights into these skills, emphasizing their importance in effectively navigating the modern digital landscape. It emphasizes students' proficiency in selecting appropriate communication tools, understanding online behaviors, and collaborating in digital content creation. Falloon (2020) advocates for a holistic understanding of digital competence, highlighting the complex knowledge and skills necessary for ethical and productive functioning in diverse digital environments. López-Meneses et al. (2020) emphasize the fundamental aspects of digital competence, including interacting through various digital technologies and creating and editing digital content.

Insights into digital content creation skills for modern learners guide our evaluation of students' abilities to create and edit digital content, discern legal from illegal online materials, and grasp programming languages necessary for digital content creation. This approach aligns with contemporary educational needs and industry demands. The literature offers valuable insights into digital content creation skills for modern learners. Stellefson et al. (2011) emphasize the importance of eHealth literacy among college students, highlighting the necessity for comprehensive digital competencies in navigating online information. Khan & Bhatti (2017) explore essential digital competencies for developing and managing digital libraries, stressing the significance of interacting through digital technologies and creating digital content.

The synthesis of literature on cybersecurity and digital aspects enhances our comprehension of students' abilities in recognizing and responding to online threats. This includes skills like identifying suspicious emails, managing privacy settings, configuring firewall settings, and optimizing digital device energy consumption. Voogt & Roblin (2012) stress the significance of information literacy, which correlates with the necessity for students to assess online content critically for security and reliability. Laar et al. (2020) offer insights into the factors influencing 21st-century digital skills, highlighting the diverse competencies essential for effective cybersecurity practices.

Emphasizing the importance of critical thinking and problem-solving skills in navigating intricate digital environments, our research focuses on students' abilities to find solutions online, utilize appropriate tools or services, and leverage online learning resources to enhance their critical thinking and problem-solving acumen. Laar et al. (2020) emphasize the fundamental skills necessary for digital competence, highlighting the significance of critical thinking and problem-solving in modern contexts. Moreover, Diniyyah et al. (2022) demonstrate the effectiveness of inquiry models in conjunction with digital tools in enhancing students' critical thinking abilities, supporting the focus on improving students' problem-solving skills through digital methods.

Lastly on digital skills, our study evaluates students' adaptability and proficiency in utilizing various technologies throughout their educational journey, encompassing learning new technologies, navigating digital platforms, and leveraging technology for academic tasks. The literature on technology agility and

AACSB A5 standards provides valuable insights into the technological competencies required for students to adapt and proficiently use various technologies throughout their educational journey. Technology agility, as defined by this standard, focuses on adapting to rapid technological changes and continuously updating IT skills.

EXPLORING THE DETERMINANTS OF DIGITAL SKILLS: BACKGROUND AND RESEARCH QUESTIONS

The COVID-19 pandemic has significantly impacted students' digital skills and competencies, necessitating a shift towards enhancing digital literacy and capabilities in educational settings. Research by Manco-Chavez et al. (2020) emphasizes the integration of ICTs and digital skills during the pandemic, highlighting the importance of adapting to digital tools and technologies to maintain educational continuity. Additionally, studies by Sá and Serpa (2020) and Lobo and Dhuri (2021) explore the promotion of digital competences and the positive impact of the pandemic in enhancing digital literacy skills among professionals, underscoring the transformative effect of COVID-19 on digital skill development. Carabregu-Vokshi et al. (2024) explore the 21st-century digital skills of higher education students during the pandemic, focusing on the potential for enhancing digital competencies through e-learning platforms.

E-learning interactivity is essential for enhancing students' digital skills. Research has emphasized the need to integrate digital literacy into higher education to tackle challenges like the COVID-19 pandemic (Tejedor et al., 2020). Universities are urged to transform learning environments by expanding digitalization to offer diverse learning opportunities and to enhance teachers' digital skills for better learning outcomes (Tejedor et al., 2020). The use of e-learning modules significantly aids in developing digital skills, especially among marginalized groups (Febro et al., 2020). Moreover, interactive digital learning companions not only support student learning but also promote sustainability concepts (Seibert et al., 2020). Finally, Carabregu-Vokshi et al. (2024) find that e-learning interactivity, instructor involvement, and the usability of e-learning systems significantly enhance digital skills acquisition among higher education students.

The research on digital technology requirements in the classroom highlights the importance of integrating various tools and resources to enhance students' learning experiences. Anderson & Maninger (2007) stress the significance of assessing students' abilities and intentions regarding technology integration, aligning with the need to evaluate students' usage of Microsoft Office tools and internet resources. Choy et al. (2009) delve into student teachers' intentions and actions in integrating technology, focusing on students' requirements to download resources and verify online sources. Furthermore, Hafner et al. (2022) emphasize the concept of digital literacies and the practices enabled by digital media, underlining the necessity for students to engage critically with online content.

Building upon the conceptualization of digital skills, determinants and relevant literature, we propose the following research questions:

Research Question 1: *Is there any significant difference in the average level of digital skills proficiency among students before commencing college from the average level of digital skills proficiency among the same students after completing college courses?*

Research Question 2: *Is there any significant difference in the acquisition of digital skills by college students due to the COVID-19 pandemic era?*

Research Question 3: *Is there any significant difference in the digital skill acquisition among students due to the degree of interactivity in online courses?*

Research Question 4: *Is there any significant difference in the digital skill acquisition among students due to the inclusion of digital technology requirements within course curricula?*

To sum up, our study emphasizes the vital role of digital skills for students. We're investigating how students acquire these skills, especially in light of the shift to online learning during COVID-19. Ultimately, we seek to identify strategies for schools to effectively enhance digital skill development.

DATA AND METHODOLOGY

In this study, we employed a combination of survey research and statistical analysis to comprehensively explore the development of digital skills among college students. Our approach was meticulously designed to align with our research objectives, focusing on assessing and quantifying the evolution of digital competencies in an academic context.

The survey research method was chosen as a primary tool to capture a wide array of data on students' digital literacy across several domains, including Information and Data Literacy, Communication and Collaboration Skills, Digital Content Creation, Digital Safety, Critical Thinking, and Problem-Solving Skills, and Technology Agility. By gathering data directly from the students, the survey provided insights into their self-assessed skill levels before and after their college education, offering a direct measure of educational impact on their digital proficiency. The inclusion of qualitative prompts within the survey also allowed for a richer understanding of students' experiences and perspectives, adding depth to the quantitative analysis.

The survey instrument used in this study was derived from Carabregu-Vokshi et al. (2023), which includes detailed information on the survey's validity and reliability. The measurement model was initially assessed to evaluate non-digital skills, followed by an examination of endogenous constructs related to digital skills encompassing all associated items and dimensions. Assessments of reliability (including indicator reliability of the constructs and internal consistency reliability) and discriminant validity were conducted to ascertain the significance and explanatory capability of the measurement model.

To analyze the survey data, we utilized paired t-tests and regression analysis, each serving a distinct purpose within our research framework. The paired t-test was selected for its efficacy in comparing the means of two related groups—students' digital skills before and after college. This statistical method is particularly suitable for our study as it allows for the assessment of improvements or declines in digital skills over time, accounting for the paired nature of our pre- and post-education data. By analyzing these changes, we can quantify the educational impact on students' digital literacy in a statistically rigorous manner.

Regression analysis, on the other hand, was employed to investigate the determinants influencing digital skill acquisition among students. This method enables us to model the relationship between students' perceived digital skills and a set of independent variables, such as educational level, e-learning interactivity, and exposure to digital technology requirements in coursework. By incorporating these factors into our regression model, we can identify key influences on digital skill development, providing valuable insights into how educational experiences shape students' digital competencies. Moreover, regression analysis offers the flexibility to control for various confounding factors, ensuring that the observed relationships are robust and meaningful.

The survey we conducted comprised 69 questions and was administered during the spring, summer, and fall of 2023 and an institutional/local review board approved this study. We collected responses from 305 participants through the Qualtrics online survey tool. All surveys were anonymous, and participants were informed that they could stop completing the survey if they felt uncomfortable. The survey can be found in the Appendix. The survey responses were obtained from students across various ethnicities, employment statuses, genders, education levels, and class modalities (see Table A1 in the Appendix).

The descriptive reveals a diverse group in terms of ethnicity, with 33.68% identifying as White, 34.38% as Hispanic, 16.32% as Black, and 15.63% as belonging to other ethnic backgrounds. Employment status within the cohort varies, with 35.76% of students engaged in part-time work, 32.99% in full-time employment, and 31.25% currently without a job. Gender distribution demonstrates diversity, as 55.21% identify as male, 43.40% as female, and 1.39% as having gender preferences not prefer to disclose. Students are distributed across different academic levels, with 3.47% being freshmen, 14.93% sophomores, 35.07%

juniors, 29.51% seniors, and 17.01% graduate students. Moreover, class modality indicates that 18.75% of students are enrolled in face-to-face classes, where the survey was conducted, while a significant majority of 81.25% are enrolled in online classes.

The study sought to understand students' perception regarding incorporating technology into teaching methods and integrating multimedia elements into coursework. The findings, as illustrated in Table A2 in the Appendix, reveal compelling insights into the importance of these aspects in modern education. Regarding the utilization of technology in teaching methods, an overwhelming majority of students, comprising 92.37%, expressed that it is crucial. This sentiment highlights the growing recognition among educators of technology's transformative potential in enhancing instructional strategies. Even though a small percentage of students found it "Not important at all" (1.04%) or "Somewhat unimportant" (0.69%), their views appeared to be in the minority. Similarly, the significance of incorporating multimedia elements into coursework was evident, with 81.25% of students considering it important. These multimedia elements encompassed videos, podcasts, and interactive simulations, suggesting that educators increasingly recognize the value of diversifying instructional materials. While a fraction of students found this aspect "Not important at all" (0.69%) or "Somewhat unimportant" (2.78%), the majority voiced their endorsement.

These findings emphasize the evolving landscape of education, where technology and multimedia elements have become integral tools for effective teaching and learning. The overwhelming consensus on their importance highlights the need for educators and institutions to continue exploring innovative approaches to engage students in an increasingly digital and multimedia-rich educational environment.

EMPIRICAL RESULTS

In this section we will discuss the measurements used to test the hypothesis statements, the paired sample statistics for students' self-reported digital skills before and after college, the investigation of the key determinants that influence the acquisition of digital skills among college students during their academic career, and the use of regression analysis of the determinants on students' perception of digital skills acquired during college.

Measurements and Paired T-Test

Our extensive study explores a spectrum of crucial digital skills integral to students' academic and professional journeys. These encompass Information and Data Literacy, examining how effectively students navigate online information, Communication and Collaboration Skills, assessing their proficiency in adapting communication tools, and Digital Content Creation, evaluating their capacity to craft and manipulate digital content. Furthermore, we delve into Digital Safety, Critical Thinking, and Problem-Solving abilities, alongside Technology Agility, aiming to comprehensively understand the diverse competencies vital in today's interconnected digital landscape. Students rated their skills both before and after college, using a 4-point Likert scale ranging from "I didn't know how to do it" to "I could do it with confidence and support/guide others."

We assessed students' Information and Data Literacy before and after college-level classes. The survey items measured their self-reported proficiency in various aspects of online information retrieval and management and aimed to track the development of students' skills and confidence levels during their academic journey. The first set focused on students' ability to use search engines effectively, and they rated their skills before and after. The second set examined their understanding of different search engines and their variability in providing search results. The third set assessed their capacity to manage digital content, including streaming, downloading, and organization, and the fourth set evaluated their ability to critically evaluate online information for reliability and timeliness.

The same Likert scale was employed to assess students' proficiency in Communication and Collaboration Skills before and after. The Likert scale was structured into three sets of questions. The first set focused on students' ability to select appropriate communication tools and services for different contexts, allowing them to rate their skills before and after college on a scale ranging from novice to confident and supportive. The second set delved into students' comprehension of online behavior in formal

and informal situations, with participants assessing their proficiency levels both pre- and post-college using the same Likert scale. The third set concentrated on students' capacity to collaboratively edit digital content created by others and generate new content by combining different media types. Here, students were asked to rate their abilities before and after college, offering insights into their collaborative digital content manipulation skills.

For Digital Content Creation, we posed three survey questions to assess students' skills and knowledge both before and after their college experience. The first set of questions centered on students' abilities to create and edit digital text files and produce multimedia presentations. The second set of questions tackled students' aptitude for distinguishing between legal and illegal online content across various digital media categories. These questions explored whether their educational experiences contributed to improved discernment and ethical decision-making when encountering digital content. Lastly, the third set of questions delved into students' awareness of different programming languages used in computer instructions, such as Python, Visual Basic, and Java.

Referring to Digital Safety, the survey has four sets of questions. The first set of questions focused on students' ability to identify suspicious email messages attempting to obtain their personal data. The second set of questions addressed students' capability to refuse access to their geographical location. The third set of questions delved into students' proficiency in configuring firewall settings on different devices. Lastly, we examined students' aptitude for reducing energy consumption of their devices, such as changing settings, closing apps, or turning off Wi-Fi. These questions assessed whether their knowledge and energy conservation practices improved due to their college-level education.

Our study's survey questions about Critical Thinking and Problem-Solving Skills encompass several key areas. Firstly, students were asked to evaluate their ability to find solutions on the Internet when facing technical problems allowing us to gauge the development of this problem-solving skill. Secondly, participants were questioned about their capacity to select the right tools, devices, or services to perform specific tasks, such as choosing a smartphone or a tool for a professional video call. Their self-assessment on a similar scale helped us assess their competence in this decision-making aspect before and after college. Lastly, students were asked about their ability to utilize online learning tools, such as video tutorials and online courses, to enhance their digital skills. Their self-rated proficiency levels before and after college provided insights into their ability to leverage online resources for self-improvement in the digital realm.

The survey questions related to students' Technology Agility skills aim to assess their adaptability and proficiency in using various technologies throughout their educational journey, before and after starting college or graduate studies. The first set of questions examines students' ability to quickly learn and adapt to new technologies or software introduced in their classes. It assesses their readiness to embrace technological advancements in an educational context. The second set of questions delves into students' capacity to utilize different technology tools for completing assignments or projects. It highlights their competence in applying technology to academic tasks. The third set of questions focuses on students' proficiency in navigating new technology platforms or systems, such as learning management systems and virtual meeting platforms. It evaluates their ease of adapting to evolving digital environments. The fourth set of questions explores students' capability to learn new technologies specifically for class assignments or projects, emphasizing their adaptability in academic settings. The fifth set of questions assesses students' readiness to adapt to changes in technology or software that may occur throughout their education, reflecting their flexibility in the face of technological evolution. The sixth set of questions addresses students' ability to learn new technologies for communication in online or hybrid learning environments, highlighting their aptitude for digital communication tools. Lastly, the seventh set of questions evaluates students' proficiency in learning new technologies for research and data analysis purposes, emphasizing their capacity to leverage technology for academic inquiry.

Table 1 presents paired sample statistics for students' self-reported digital skills before and after college. The mean values for each skill category provide insights into students' perceived proficiency. Across the board, there is a notable increase in skill levels after college. Notably, in Information and Data Literacy, students' mean score rises from 3.21 before college to 3.52 after college. Similarly, Communication and Collaboration Skills improve from 3.10 to 3.48, and Digital Content Creation skills

see an increase from 2.83 to 3.21. Digital Safety, Critical Thinking, Problem-Solving Skills, and Technology Agility all exhibit similar positive trends. These findings suggest that college education positively impacts students' perceived digital competencies, enhancing their abilities in various digital skill areas.

TABLE 1
PAIRED SAMPLE STATISTICS OF DIGITAL SKILLS BEFORE AND AFTER COLLEGE

		Mean	N	Std. Deviation	Std. Error Mean
Information and Data Literacy (IDL)	Before College	3.21	289	0.62	0.04
	After College	3.52	289	0.53	0.03
Communication and Collaboration Skills (CCS)	Before College	3.10	289	0.66	0.04
	After College	3.48	289	0.53	0.03
Digital Content Creation (DCC)	Before College	2.83	289	0.77	0.05
	After College	3.21	289	0.58	0.03
Digital Safety (DS)	Before College	2.84	289	0.70	0.04
	After College	3.19	289	0.55	0.03
Critical Thinking and Problem-Solving Skills (CTPS)	Before College	3.06	289	0.71	0.04
	After College	3.41	289	0.54	0.03
Technology Agility (TA)	Before College	2.95	289	0.68	0.04
	After College	3.40	289	0.51	0.03

Given these paired sample statistics we aim to assess through students' self-reported perceptions of skill development during their academic journey, we seek to determine if there are significant differences in their average scores for each category of digital skills before and after college. To achieve this, we will test the following hypothesis for the six digital skills using a paired two-tail t-test:

Hypothesis 1: *There is a significant difference in the average level of digital skills proficiency among students before commencing college compared to the average level of digital skills proficiency among the same students after completing college courses.*

TABLE 2
PAIRED SAMPLE T-TEST BEFORE AND AFTER COLLEGE

Paired Differences									
					95% CI of the Differences				
Category		**Mean**	**Std. Dev**	**Std. Error Mean**	**Lower**	**Upper**	**t**	**df**	**Sig.(2 tailed)**
IDL	**Before & After**	0.31	0.47	0.03	0.26	0.37	11.32	287	0.000
CCS	**Before & After**	0.39	0.57	0.03	0.32	0.45	11.51	287	0.000
DCC	**Before & After**	0.38	0.58	0.03	0.31	0.45	11.02	287	0.000
DS	**Before & After**	0.34	0.51	0.03	0.28	0.41	11.34	287	0.000
CTPS	**Before & After**	0.35	0.55	0.03	0.29	0.42	10.97	287	0.000
TA	**Before & After**	0.45	0.57	0.03	0.38	0.51	13.36	287	0.000

The paired sample t-test results in Table 2 reveal significant differences in students' average scores for each category of digital skills before and after college. The hypothesis (H1) stating that the average score

of proficiency in each of the six digital skills before starting college is equal to the average score of proficiency after completing college courses is rejected, as indicated by the p-values of 0.000 for all skills.

Specifically, the paired differences between students' self-reported skills before and after college are consistently positive, suggesting substantial improvement in their digital skills. The mean differences range from 0.31 to 0.45, with narrow 95% confidence intervals and t-statistics ranging from 10.97 to 13.36. These results indicate that students perceive a significant enhancement in their Information and Data Literacy, Communication and Collaboration Skills, Digital Content Creation, Digital Safety, Critical Thinking and Problem-Solving Skills, and Technology Agility after completing college courses. Therefore, the data strongly supports the notion that college education positively impacts students' perceived digital competencies across various skill categories.

Determinants of Digital Skills and Regression Analysis

Our research aims to investigate the key determinants that influence the acquisition of digital skills among college students during their educational journey. We have identified three primary determinants that we believe play a crucial role in shaping students' digital skill development. Each determinant is measured on a 5-point Likert scale with response options ranging from "Strongly Agree" to "Strongly Disagree" to be able to collect a range in which respondents agree or disagree with a given statement.

The first determinant is Covid-19. Five survey items aim to measure the impact of COVID-19 on various aspects of individuals' digital experiences and preferences. The items are designed to gauge how the pandemic influenced their familiarity with digital tools and technologies. The first survey item assesses respondents' increased familiarity with live video communication platforms such as Microsoft Teams, Blackboard Collaborate, and Zoom during the pandemic. The second one focuses on their increased familiarity with cloud storage services and apps, whereas the third survey item examines whether they became more familiar with learning management systems like Blackboard and Canvas during COVID-19. The fourth one explores respondents' increased online presence and usage of electronic devices during the pandemic. Finally, the last item seeks to understand whether their preference for online classes over traditional classes changed as a result of COVID-19.

The second determinant is e-learning interactivity. This study's measurement of e-learning activity includes three items to assess students' experiences and perceptions of online classes. The first item assesses students' online communication via discussion posts and email with professors and peers. The second item evaluates students' ability to share and edit documents with other students using online platforms like Googledocs or Microsoft 365. The last one explores students' overall satisfaction with online courses, including their interest, ease of following, and perceived learning outcomes.

The third determinant is digital technology requirements in the classroom. This construct's first survey item assesses students' use of Microsoft Office tools such as Excel and PowerPoint in their classes. The second one evaluates whether students are required to use the Internet to search for information in their classes, whereas the third one investigates whether students are required to download resources from the internet for their classes. Finally, the last one explores whether students are mandated to ensure the reliability and validity of online sources they use in their classes.

Given these determinants and students' perception of their digital skills during their college education, we test the following hypothesis.

Hypothesis 2: *The acquisition of digital skills by college students is significantly influenced by the COVID-19 pandemic era.*

Hypothesis 2 tests the impact of the COVID Era. We are interested in examining whether the COVID-19 pandemic era has significantly impacted the acquisition of digital skills by college students. Specifically, we aim to explore whether the increased reliance on digital technologies in educational settings during this period has influenced students' proficiency in using these tools. Our hypothesis is driven by the assumption that the accelerated adoption of digital technologies may have implications for students' digital skill acquisition.

Hypothesis 3: *The degree of interactivity in online courses significantly impacts the digital skill acquisition among students.*

Hypothesis 2 tests the role of e-learning interactivity. Another determinant under investigation is the level of interactivity within e-learning environments, particularly in online classes. We seek to determine whether the degree of interactivity in online courses significantly affects students' ability to gain digital skills. We hypothesize that higher levels of interactivity, such as active engagement in virtual discussions and collaborative digital activities, may positively correlate with improved digital skill acquisition.

Hypothesis 4: *The inclusion of digital technology requirements within course curricula significantly enhances the digital skill acquisition among students.*

Hypothesis 4 tests the role of digital technology requirements in courses. The third determinant we aim to explore relates to whether the inclusion of digital technology requirements within course curricula impacts students' digital skill development. We are interested in investigating whether students mandated to use digital tools and technologies for academic purposes tend to acquire more advanced digital skills compared to those with less exposure to such requirements. This hypothesis is grounded in the belief that practical usage of digital technology within coursework may enhance skill acquisition.

To rigorously test these hypotheses, our study utilizes regression analysis. By employing this statistical technique, we conduct a comprehensive analysis to discern the extent to which each determinant contributes to college students' overall digital skill proficiency in the contemporary educational landscape. Regression analysis will allow us to quantify the relationships between these determinants and students' digital skill acquisition.

TABLE 3
REGRESSION ANALYSIS OF DETERMINANTS ON STUDENTS' PERCEPTION OF DIGITAL SKILLS DURING COLLEGE

Dependent Variable						
Variable	**Information and Data Literacy (IDL)**	**Communication and Collaboration Skills (CCS)**	**Digital Content Creation (DCC)**	**Digital Safety (DS)**	**Critical Thinking &Problem-Solving Skills (CTPS)**	**Technology Agility (TA)**
Age	0.01 (0.02)	-0.001 (0.01)	-0.003 (0.01)	-0.01 (0.01)	-0.01 (0.01)	-0.08*** (0.03)
Work Status	0.27* (0.16)	0.08 (0.12)	0.20 (0.14)	0.21 (0.17)	0.18 (0.12)	0.26 (0.28)
Education Level	0.37*** (0.12)	0.32*** (0.09)	0.22** (0.10)	0.35*** (0.13)	0.22*** (0.10)	0.88*** (0.21)
E-Learning Interactivity	0.10 (0.07)	0.12** (0.05)	0.17*** (0.06)	0.09 (0.07)	0.13** (0.05)	0.28** (0.11)
Course Requirements	0.12** (0.05)	0.06 (0.04)	0.04 (0.04)	0.04 (0.04)	0.08** (0.04)	0.07 (0.09)
Covid	0.03 (0.04)	0.02 (0.03)	-0.03 (0.03)	-0.02 (0.04)	0.03 (0.03)	0.03 (0.06)
Intercept	Yes	Yes	Yes	Yes	Yes	Yes
Observations	288	288	288	288	288	288

Adjusted R2	0.13	0.12	0.09	0.06	0.11	0.11
Residual Std. Error	1.98	1.49	1.66	2.12	1.52	3.38
F-Statistics	8.31***	7.65***	5.99***	3.97***	7.12***	6.71***

*Note: *p<0.1; **p<0.05; ***p<0.01*

The regression analysis reveals important insights into the determinants of students' perception of gaining digital skills during their college education (see Table 3). As a variable, age does not significantly influence most aspects of students' perception of gaining digital skills during their college education, including Information and Data Literacy, Communication and Collaboration Skills, Digital Content Creation, Digital Safety, and Critical Thinking & Problem-Solving Skills. However, an interesting finding emerges regarding Technology Agility, where age has a noteworthy negative effect. This suggests that older students may face challenges in adapting to new technologies, leading to a lower perception of gaining technology agility (Hecker and Briggs 2021).

Interestingly, examining the impact of work status exhibits a significant positive impact on all aspects of students' perception of digital skill development during college. This implies that students who work while pursuing their studies tend to have a higher perception of gaining digital skills, across all dimensions. Our results indicate a significant positive relationship with students' perception of gaining Information and Data Literacy. Additionally, education level stands out as a robust determinant, with a positive and significant impact on all aspects of students' perception of gaining digital skills, encompassing Information and Data Literacy, Communication and Collaboration Skills, Digital Content Creation, Digital Safety, and Critical Thinking & Problem-Solving Skills. This finding highlights the importance of higher education levels in shaping students' perception of gaining proficiency in digital skills.

E-Learning Interactivity stands out as a crucial determinant in our analysis, showcasing its pivotal role in shaping students' perception of gaining digital skills during their college education. This determinant holds the key to understanding how students' active engagement with e-learning materials can significantly impact their perceived skill development in various dimensions. This finding is particularly noteworthy because E-Learning Interactivity isn't just influential; it attains statistical significance for three critical aspects: Communication and Collaboration Skills, Digital Content Creation, and Critical Thinking & Problem-Solving Skills. The statistical significance highlights the strong connection between students' proactive participation in online learning activities and their perception of skill development. This implies that students who actively engage with course materials, participate in collaborative digital tasks, and embrace creative digital content creation tend to perceive a more substantial gain in these specific digital skills. This finding resonates with the evolving landscape of education, where e-learning has become a prevalent mode of instruction, highlighting the importance of interactivity as a catalyst for skill enhancement.

Course Requirements emerge as a significant determinant in our analysis, shedding light on their substantial influence on students' perception of gaining digital skills during their college education. This determinant highlights the role of specific course-related demands in shaping students' perceived skill development. It is particularly compelling because Course Requirements significantly impact two key dimensions: Communication and Collaboration Skills and Critical Thinking & Problem-Solving Skills. The significance of this finding lies in the correlation between the extent of digital requirements embedded within course curricula and the perceived skill development of students. In essence, students who encounter a higher degree of digital requirements in their courses tend to report a more substantial gain in Communication and Collaboration Skills and Critical Thinking & Problem-Solving Skills. This implies that when educational institutions integrate digital components, such as collaborative online projects, interactive problem-solving tasks, and communication via digital platforms, students are more likely to perceive a tangible improvement in their skills within these domains.

Surprisingly, the impact of COVID-19 does not emerge as statistically significant across all aspects of students' perception of gaining digital skills during their college education, implying that the pandemic itself may not have significantly influenced students' perception of digital skill development.

DISCUSSION AND IMPLICATIONS

The study employed a survey methodology to gather data from 305 participants, assessing their self-evaluation of digital skills before and after college. The survey, conducted over multiple periods in 2023, included 69 questions and was approved by an institutional review board. The participants, from diverse backgrounds in ethnicity, employment status, gender, education level, and class modality, completed the anonymous survey via the Qualtrics online platform. Descriptive statistics were used to analyze the participants' demographic and academic characteristics, highlighting the sample's diversity.

The study delved into various dimensions of digital skills, including Information and Data Literacy, Communication and Collaboration Skills, Digital Content Creation, Digital Safety, Critical Thinking, Problem-Solving Skills, and Technology Agility. Students reported significant improvements in these skills post-college, as evidenced by the paired sample statistics. The mean scores for each skill category increased after college, indicating a positive impact of higher education on students' perceived digital competencies.

The correlation between employment status (full-time versus part-time) and digital skill development and the influence of schooling duration on such skills can significantly vary based on individual experiences, job roles, and educational program characteristics. Encouraging internships within academic settings enriches digital competencies and gives students a holistic grasp of the professional domain. These internships effectively bridge the theoretical-practical gap, nurturing well-rounded individuals primed for future career challenges. While full-time employment and extended schooling durations can offer avenues for digital skill growth, it's crucial to recognize the impact of unique circumstances, industry demands, and individual commitment to learning. Maintaining proficiency in digital skills over one's career seemingly requires a commitment to continual learning and adaptability.

The analysis also indicates that age does not significantly impact most aspects of acquiring digital skills among students, except for one key area: Technology Agility. Older students may face difficulties adapting to new technologies in this dimension, leading to a diminished perception of skill development. Students who maintain employment while attending college exhibit a notably positive outlook on developing digital skills across various dimensions. This suggests that managing work responsibilities alongside academic pursuits can have a beneficial effect on skill acquisition. Additionally, higher levels of education positively correlate with students' perceptions of acquiring proficiency in digital skills, underscoring the significance of advanced educational attainment in shaping these perceptions.

E-learning interactivity is a pivotal factor influencing students' views on skill development. The level of engagement with online learning materials significantly correlates with how students perceive their skills as improving. Specifically, active participation in e-learning activities notably enhances communication, collaboration, digital content creation, and critical thinking/problem-solving skills. Course requirements markedly shape how students perceive their skill development, especially in communication, collaboration, critical thinking, and problem-solving. This highlights the significance of incorporating digital elements into course materials to bolster students' perceived growth in these specific skill domains.

The statistical analysis reveals that COVID-19's impact does not significantly affect all aspects of how students perceive their digital skill development during college. This lack of statistical significance suggests that the pandemic might not have considerably influenced how students perceive their skill development in this context.

In summary, the study findings suggest that age doesn't notably affect students' digital skill acquisition, except for Technology Agility, where older individuals may encounter challenges adapting to new technologies, impacting their perception of skill development. Moreover, students balancing work and college demonstrate a positive outlook on digital skill development, indicating the beneficial influence of juggling work responsibilities with academic pursuits. Additionally, higher education levels correlate positively with students' perceptions of digital proficiency, emphasizing the role of advanced education in shaping these views. Active engagement with e-learning materials significantly enhances students' perceptions of skill development, particularly in communication, collaboration, digital content creation, and critical thinking. Course requirements significantly mold students' perceptions of skill development, underlining the importance of integrating digital elements into course materials. Lastly, the statistical

analysis suggests that COVID-19's impact may not significantly influence how students perceive their digital skill development during college, indicating a minimal pandemic influence on skill perception.

Drawing from this study's findings and ramifications, higher education institutions are encouraged to invest in advanced educational technologies and adopt an interdisciplinary approach to curriculum development to stay relevant and effective. It is also suggested that they expand partnerships with industries to provide students with practical experiences through internships, which are vital for bridging the gap between theoretical knowledge and practical skills. Furthermore, institutions should consider developing support systems that accommodate diverse student needs, including older students and those balancing work and study, to ensure all students have the opportunity to develop necessary digital skills effectively.

Institutions might consider establishing dedicated Digital Literacy Centers that focus on cutting-edge technologies to further enhance their educational offerings. Supporting faculty through specialized training in digital tools and pedagogical strategies can also empower educators to effectively integrate digital skills into their teaching. Enhancing the online learning infrastructure to provide seamless and interactive experiences, promoting digital accessibility, and implementing regular digital skill assessments can ensure that all students are well-prepared to meet the challenges of the digital age.

For practitioners, engaging in continual professional development is crucial for keeping pace with technological advancements and improving teaching methods. This includes participating in workshops and training sessions on the latest digital tools and educational strategies. Practitioners should also curate industry-relevant content, foster collaborative learning environments, and utilize adaptive learning technologies to customize educational experiences. Connecting with professional networks and integrating certification opportunities into the curriculum can further enhance the relevance and impact of their teaching, preparing students for successful careers in a digital world.

CONCLUSION

In conclusion, this comprehensive study has systematically explored the trajectory of digital skills development among college students, utilizing robust methodologies to assess changes in their competencies across multiple digital domains. While the reliance on self-reported data introduces potential biases related to participants' perceptions, it is crucial to note that these self-perceptions are still valuable for understanding the determinants of digital skills development. The paired sample t-tests provided evidence of significant improvements in various digital skills from pre-college to post-college, reflecting the transformative impact of higher education on digital literacy.

Key determinants such as e-learning interactivity, digital technology requirements in coursework, and the broader impacts of the COVID-19 pandemic were scrutinized through regression analysis. These factors played pivotal roles in shaping students' perceptions and proficiency in digital skills, underlining the importance of an interactive and technologically integrated learning environment.

The study's findings advocate for several actionable strategies for higher education institutions and practitioners. Institutions are encouraged to further integrate digital technology into their curricula and to maintain a flexible and supportive learning environment that accommodates diverse student needs. This includes the establishment of Digital Literacy Centers and enhancing faculty training in digital pedagogy to ensure that educators are well-equipped to guide students in a technology-driven world.

Practitioners should focus on continuous professional development to stay abreast of technological advancements and integrate these insights into their teaching. Furthermore, fostering a collaborative learning environment and embedding industry-relevant digital skills into the curriculum will enhance the employability of graduates in the digital economy.

For future studies, it is essential to delve into the role of Artificial Intelligence (AI) in enhancing digital skills education. As AI continues to reshape various industries, its integration into educational settings presents a promising avenue for further research. Future inquiries could explore how AI-driven tools and platforms contribute to personalized learning experiences, adaptivity in course content, and the efficiency of skill acquisition. Moreover, investigating the impact of AI on reducing educational disparities and providing equitable learning opportunities across diverse student populations will be crucial. These studies

could evaluate AI's effectiveness in areas such as automated feedback, real-time assessment, and the creation of interactive and immersive learning environments that simulate real-world scenarios. Such research would expand our understanding of AI's potential in education and guide the development of AI policies and practices that enhance students' learning outcomes and readiness for a digital future.

Overall, the positive trends observed in students' digital skills post-college highlight the critical role of higher education in preparing students for the complexities of the modern digital landscape. Moving forward, institutions and educators should continue to adapt and innovate in their teaching strategies and curricula to meet the evolving digital needs of the workforce. This study confirms the effectiveness of current educational practices in enhancing digital literacy and provides a roadmap for future enhancements in digital education.

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APPENDIX

TABLE A1
SUMMARY STATISTICS OF SURVEY PARTICIPANTS

Category		Percentage	Count
Ethnicity	White	33.68%	97
	Hispanic	34.38%	99
	Black	16.32%	47
	Other	15.63%	45
Employment	Part-time	35.76%	103
	Full-time	32.99%	95
	No Job	31.25%	90
Gender	Male	55.21%	159
	Female	43.40%	125
	Not Preferred to Disclose	1.39%	4
Class Level	Freshman	3.47%	10
	Sophomore	14.93%	43
	Junior	35.07%	101
	Senior	29.51%	85
	Graduate	17.01%	49
Class Mode	Face to Face	18.75%	54
	Online	81.25%	234

TABLE A2
STUDENTS' PERCEPTION OF THE IMPORTANCE OF INCORPORATING TECHNOLOGY AND MULTIMEDIA ELEMENTS INTO COURSEWORK

Survey Item	Importance Level	Percentage	Count
How important do you think it is for educators to incorporate technology into their teaching methods?	Not important at all	1.04%	3
	Somewhat unimportant	0.69%	2
	Neutral	5.90%	17
	Important (Somewhat and Very)	92.37%	266
How important is it for your coursework to incorporate multimedia elements (e.g., videos, podcasts, and interactive simulations)?	Not important at all	0.69%	2
	Somewhat unimportant	2.78%	8
	Neutral	15.28%	44
	Important (Somewhat and Very)	81.25%	234

TABLE A3
SURVEY ITEMS AND REFLECTIVE CONSTRUCTS

DEMOGRAPHICS		
D1	*What is your age?*	*– Fill in the response (leave blank if you prefer not to answer)*
D2	*What is your race?*	*– White or Caucasian* *– Hispanic or Latino* *– Black or African American* *– Native American or American Indian* *– Asian / Pacific Islander* *– Multiracial or Mixed Race* *– Other*
D3	*What is your job status?*	*– Yes, part-time* *– Yes, full-time* *– Not at this time*
D4	*What is your gender?*	*– Male* *– Female* *– LGTQ+* *– Prefer not to answer*
D5	*What is your marital status?*	*– Married or domestic partner*

		– Single, never married *– Divorced* *– Separated* *– Widowed*
D6	*What is your Class?*	*– Freshman* *–Sophomore* *–Junior* *–Senior* *–Graduate (MBA)*
D7	*Is the class that is asking you to take this survey online or face to face?*	*– Face-to-face class* *– Online class*
D8	*How important do you think it is for educators to incorporate technology into their teaching methods?*	*– Not important at all* *– Somewhat unimportant* *– Neutral* *– Somewhat important* *– Very important*
D9	*How important is it for your coursework to incorporate multimedia elements (e.g., videos, podcasts, and interactive simulations)?*	*– Not important at all* *– Somewhat unimportant* *– Neutral* *– Somewhat important* *– Very important*
DIGITAL SKILLS *Using a 4 point scale consisting of "I didn't know how to do it", "I could do it with help", "I could do it on my own", and "I could do it with confidence and, if needed, I could support/guide others"*		
INFORMATION AND DATA LITERACY		
IMB1	*Before starting college, I could use search engines to find information online by knowing which words to use in order to find what I needed quickly (e.g. to search online or within a document)*	
IMA1	*After taking college level classes, I can use search engines to find information online by knowing which words to use in order to find what I need quickly (e.g. to search online or within a document)*	
IMB2	*Before starting college, I understood that different search engines may give different search results*	
IMA2	*After taking college level classes, I understand that different search engines may give different search results*	
IMB3	*Before starting college, I could use the Internet to stream or download content (e.g. articles, books) and organize the content such as documents, images, and videos using folders, or tagging to find them back later*	
IMA3	*After taking college level classes, I can use the Internet to stream or download content (e.g. articles, books) and organize the content such as documents, images, and videos using folders, or tagging to find them back later*	
IMB4	*Before starting college, I could check if the information found online is reliable and I am able check whether the information found is up to date, and I compare the information found on different websites*	

IMA4	*After taking college level classes, I can check if the information found online is reliable and I am able check whether the information found is up to date, and I compare the information found on different websites*
COMMUNICATION AND COLLABORATION SKILLS	
CCB1	*Before starting college, I knew which communication tools and services (e.g. phone, email, video conference, text message) are appropriate to use in different circumstances*
CCA1	*After taking college level classes, I know which communication tools and services (e.g. phone, email, video conference, text message) are appropriate to use in different circumstances*
CCB2	*Before starting college, I knew how to behave online according to the situation (e.g. formal vs informal)*
CCA2	*After taking college level classes, I know how to behave online according to the situation (e.g. formal vs informal)*
CCB3	*Before starting college, I was able to edit digital content that others have created (e.g. insert a text into an image, edit a wiki) and create something new by mixing different types of content (e.g. text and images)*
CCA3	*After taking college level classes, I am able to edit digital content that others have created (e.g. insert a text into an image, edit a wiki) and create something new by mixing different types of content (e.g. text and images)*
DIGITAL CONTENT CREATION	
DCB1	*Before starting college, I knew how to create and edit digital text files (e.g. Word, OpenDocument, Google Docs), and how to produce multimedia presentations (presentation may be created using Microsoft PowerPoint, Google Slides, Keynote, or Prezi that uses a variety of different media, such as text, audio, video, and images, to convey information)*
DCA1	*After taking college level classes, I know how to create and edit digital text files (e.g. Word, OpenDocument, Google Docs), and how to produce multimedia presentations (presentation may be created using Microsoft PowerPoint, Google Slides, Keynote, or Prezi that uses a variety of different media, such as text, audio, video, and images, to convey information)*
DCB2	*Before starting college, I was able to differentiating between legal and illegal online content (e.g. software, movies, music, books, films)*
DCA2	*After taking college level classes, I am able to differentiating between legal and illegal online content (e.g. software, movies, music, books, films)*
DCB3	*Before starting college, I knew that there are different programming languages (e.g. Python, Visual Basic, Java) to provide instructions to a computer*
DCA3	*After taking college level classes, I know that there are different programming languages (e.g. Python, Visual Basic, Java) to provide instructions to a computer*
DIGITAL SAFETY	
SB1	*Before starting college, I was able to identify suspicious e-mail messages that tried to obtain my personal data*
SA1	*After taking college level classes, I am able to identify suspicious e-mail messages that try to obtain my personal data*
SB2	*Before starting college, I was able to refuse access to my geographical location*
SA2	*After taking college level classes, I am able to refuse access to my geographical location*

SB3	*Before starting college, I was able to configure settings of a firewall on different devices*
SA3	*After taking college level classes, I am able to configure settings of a firewall on different devices*
SB4	*Before starting college, I was able to reduce energy consumption of my devices (e.g. change settings, close apps, turn off Wi-Fi)*
SA4	*After taking college level classes, I am able to reduce energy consumption of my devices (e.g. change settings, close apps, turn off Wi-Fi)*
CRITICAL THINKING AND PROBLEM-SOLVING SKILLS	
CTPSB1	*Before starting college, when facing a technical problem, I am able to find solutions on the Internet*
CTPSA1	*After taking college level classes, when facing a technical problem, I am able to find solutions on the Internet*
CTPSB2	*Before starting college, I was able to select the right tool, device or service to perform a given task (e.g. select a smartphone for your needs, choose a tool for a professional video call)*
CTPSA2	*After taking college level classes, I am able to select the right tool, device or service to perform a given task (e.g. select a smartphone for your needs, choose a tool for a professional video call)*
CTPSB3	*Before starting college, I was able to use online learning tools to improve my digital skills (e.g. video tutorial, online courses)*
CTPSA3	*After taking college level classes, I am able to use online learning tools to improve my digital skills (e.g. video tutorial, online courses)*
TECHNOLOGY AGILITY	
TA1B	*Before starting college (or graduate studies), I was able to quickly learn and adapt to new technologies or software taught in classes.*
TA1A	*After starting college (or graduate studies), I am able to quickly learn and adapt to new technologies or software taught in classes.*
TA2B	*Before starting college (or graduate studies), I was able to use different types of technology tools to complete assignments or projects.*
TA2A	*After starting college (or graduate studies), I am able to use different types of technology tools to complete assignments or projects.*
TA3B	*Before starting college (or graduate studies), I was able to navigate new technology platforms or systems (e.g., new learning management systems, virtual meeting platforms).*
TA3A	*After starting college (or graduate studies), I am able to navigate new technology platforms or systems (e.g., new learning management systems, virtual meeting platforms).*
TA4B	*Before starting college (or graduate studies), I was able to learn a new technology for my class assignments or projects.*
TA4A	*After starting college (or graduate studies), I am able to learn a new technology for my class assignments or projects.*
TA5B	*Before starting college (or graduate studies), I was able to adapt to changes in technology or software that may occur throughout my education.*
TA5A	*After starting college (or graduate studies), I am able to adapt to changes in technology or software that may occur throughout my education.*
TA6B	*Before starting college (or graduate studies), I was able to learn a new technology to communicate with instructors or peers in an online or hybrid learning environment.*

TA6A	*After starting college (or graduate studies), I am able to learn a new technology to communicate with instructors or peers in an online or hybrid learning environment.*
TA7B	*Before starting college (or graduate studies), I was able to learn a new technology to conduct research and analyze data (e.g., using statistical software)*
TA7A	*After starting college (or graduate studies), I am able to learn a new technology to conduct research and analyze data (e.g., using statistical software)?*
DRIVERS *Using a 5 point scale consisting of "I strongly agree", "I somewhat agree", "I neither agree or disagree", "I somewhat disagree", "I strongly disagree"*	
COVID-19	
C1	*During COVID-19, I became more familiar with live video communication (ex. Microsoft teams, blackboard collaborate, zoom, etc.)*
C2	*During COVID-19, I became more familiar with cloud storage services and apps*
C3	*During COVID-19, I became more familiar with learning management systems (ex. Blackboard, Canvas, etc.)*
C4	*During COVID-19, I spent more time online (surfing the internet, using apps, etc.) and using electronics*
C5	*Since COVID-19, I prefer online classes over traditional classes*
E-LEARNING INTERACTIVITY	
EL1	*In my online classes, I communicate online with professors and other students via discussion posts, and/or email*
EL2	*In my online classes, I am able to share and edit documents with other students via the Internet (ex. Google Docs, Microsoft 365, etc.)*
EL3	*I find online courses interesting, easy to follow, and I learn a lot.*
DIGITAL TECHNOLOGY REQUIREMENTS IN THE CLASSROOM	
CD1	*In my classes, I am required to use Microsoft office tools such as Excel, PowerPoint, etc.*
CD2	*In my classes, I am required to use the Internet to search for information*
CD3	*In my classes, I am required to download resources from the Internet*
CD4	*In my classes, I am required to make sure that the online sources that I use are reliable and valid.*