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The Efficacy of Digital Education: A Data-Driven Analysis of Online Learning Outcomes

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ABSTRACT: This study investigates student perceptions of the effectiveness of online learning compared to traditional in-person instruction, with a specific focus on the moderating effects of gender and academic major. Employing a 2x2 factorial research design, the study surveyed male and female students majoring in criminal justice and non-criminal justice disciplines at a small Midwestern university. A total of 40 participants (N = 40) completed a Likert-scale questionnaire measuring four dimensions: Instructor and Course Delivery, Engagement and Interaction, Learning Outcomes and Perceived Effectiveness, and Technology and Resources. Following approval by the Institutional Review Board, survey distribution was conducted electronically via email. Descriptive statistics and independent samples t-tests (assuming equal variances, $p < .05$) were used to analyze the data. Results revealed statistically significant differences in student perceptions across gender and academic discipline, with notable disparities observed in the categories of Technology and Resources and Instructor and Course Delivery. Female students, particularly those majoring in criminal justice, reported consistently more favorable perceptions of their online learning experiences than their male and non-criminal justice peers. These findings emphasize the influence of demographic variables on student satisfaction and perceived efficacy in digital learning environments, and they suggest the importance of developing targeted instructional strategies and technological support systems to address diverse learner needs.

KEYWORDS: digital education, online learning, e-learning effectiveness, distance education, learning outcomes, student performance, education technology (edtech), higher education, instructional design, learning analytics, academic achievement, course completion rates, student engagement, asynchronous learning, synchronous learning, digital pedagogy, online course evaluation, technology-enhanced learning

Introduction

Online education provides students with increased flexibility and access to diverse learning opportunities, allowing them to pursue subjects beyond their standard curricula or recover academic credits without delaying progress. As with traditional classroom instruction, the success of online learning hinges on the implementation of structured curricula and evidence-based pedagogical strategies that promote conceptual understanding, address learning gaps, and support student achievement. However, the virtual learning environment introduces unique challenges, including heightened potential for distraction, reduced direct supervision, and lower levels of student motivation. This study emerged in response to the widespread shift to remote instruction during the COVID-19 pandemic, which necessitated a rapid transition to online learning across educational institutions nationwide.

The research aims to explore college students' perceptions, attitudes, and behaviors related to online education, with a focus on key factors such as engagement, motivation, accessibility, and the learning environment. The central objective is to assess how these variables influence academic performance and satisfaction in online versus traditional learning contexts. Understanding student experiences is critical for informing the development of effective virtual instruction and enhancing institutional support systems. Moreover, identifying potential inequities in access and participation can contribute to the advancement of more inclusive and equitable educational practices. Ultimately, this research informs the broader discourse on online learning efficacy and offers valuable insights for academic planning in a post-pandemic educational landscape.

Literature Review

Online education has emerged as a prominent alternative to traditional face-to-face instruction, driven by technological advancements and the growing demand for flexible, accessible learning options. The COVID-19 pandemic catalyzed a global transformation in educational practices, compelling institutions to rapidly adopt virtual platforms to maintain instructional continuity. Although online learning has existed since at least 1989, the pandemic marked an unprecedented and large-scale transition from in-person to remote instruction, presenting significant challenges for educational systems worldwide (Habib et al., 2024). In response, many institutions implemented both synchronous and asynchronous delivery models. Synchronous learning involves real-time, interactive sessions between instructors and students, whereas asynchronous learning provides content that can be accessed independently, offering learners increased flexibility (Almahasees et al., 2021).

The continued evolution of internet technologies has further influenced the design and implementation of online courses, prompting shifts in how students

perceive and engage with digital learning environments. Understanding these perceptions is essential for improving the effectiveness of online education and aligning instructional strategies with students' needs. Ongoing research into learners' attitudes and experiences can inform the development of pedagogically sound and technologically responsive online instruction (Song et al., 2004). This literature review explores the current body of research on the effectiveness of online learning, critiques highlighting its limitations, and the attitudes of both students and instructors toward digital education.

Effectiveness of Online Learning

Online education presents students with meaningful academic opportunities, particularly in circumstances where traditional, in-person instruction is limited or unavailable. For example, students who underperform in foundational courses like algebra can utilize online learning during evenings or summer terms to recover academic credits and maintain their educational trajectory (Loeb, 2025). This illustrates the adaptability and individualized support that online education can provide.

As with face-to-face instruction, the success of online learning depends on the implementation of structured curricula and pedagogically sound teaching strategies. Hussin (2017) underscores that despite geographic separation, instructors can sustain meaningful engagement with students through digital communication tools. Both synchronous formats, such as live video conferencing, and asynchronous platforms, including discussion forums and messaging systems, play a vital role in maintaining instructional continuity. This point is further supported by Wargadinata et al. (2020), who highlight the growing effectiveness of tools such as WhatsApp, Zoom, and Google Classroom in fostering accessible, flexible, and interactive learning environments. Students can access recorded lectures, revisit instructional materials, and enhance their understanding through supplemental print and digital resources (Eksail & Afari, 2019).

Learners from Generations Y and Z are especially well-positioned to thrive in these environments, given their extensive exposure to digital media, social platforms, and educational technologies (Harrison & McTavish, 2026). Their familiarity with tools like YouTube, educational apps, and gamified learning platforms contributes to greater comfort and efficacy in navigating online instruction. Nurul et al. (2020) argue that digital education enhances interpersonal skills and promotes adaptability to emerging technologies—qualities increasingly valued in the modern workforce. As Mohd et al. (2021) emphasize, limitations such as unreliable internet access and outdated technological resources can significantly inhibit students' ability to engage with online content.

Arguments Against the Effectiveness of Online Learning

While online education offers several key benefits—such as increased flexibility, broader accessibility, and opportunities for self-paced learning—it also presents notable challenges that can impede its overall effectiveness, particularly for certain student populations and instructional contexts. According to Loeb (2025), traditional classroom settings foster social dynamics through face-to-face interactions with teachers and peers that contribute significantly to student motivation, accountability, and engagement. These elements, which include real-time feedback and collaborative learning, are often diminished or absent in virtual learning environments, potentially reducing their efficacy for some learners.

Additional concerns surrounding the efficiency and sustainability of online education have also emerged. Bahasoan et al. (2020) recognize the value of online instruction during crisis periods, such as the COVID-19 pandemic, but question its long-term effectiveness due to logistical and infrastructural constraints. Chief among these are the financial and technological barriers posed by the need for stable internet connections and access to appropriate digital tools—resources that are not uniformly available to all students. Fauzi and Sastra (2020) further critique the online learning model, citing widespread implementation issues including inadequate internet coverage, educators' lack of preparedness for digital instruction, and insufficient parental engagement in students' virtual learning experiences. Collectively, these perspectives highlight the critical need to address both structural and pedagogical limitations in order to improve the sustainability and effectiveness of online education. While digital learning holds significant promise as a complement to traditional instruction, its long-term success depends on equitable access to technology, the development of innovative and adaptable teaching methods, and coordinated support from educators, families, and institutions.

Attitudes of Students and Instructors

Despite the limitations that may hinder the effectiveness of online learning for some students, the attitudes of both learners and instructors are critical determinants of engagement and overall academic success in digital education. Attitude, in this context, can be understood as an individual's predisposition shaped by personal experiences, which influences their behavioral intentions toward learning (Datnow, 2020). Positive or negative attitudes toward online education significantly impact how students interact with course material, instructors, and peers.

Nurul et al. (2020) emphasize that students' attitudes are pivotal to the perceived and actual effectiveness of online learning environments. When students approach online education with a lack of seriousness or motivation, it can exacerbate existing challenges and place additional strain on educators and

institutional support systems. Addressing these issues requires a collaborative effort among all stakeholders—students, instructors, and administrators alike.

Moreover, as Loeb (2025) points out, instructors play an essential role in fostering student engagement by continuously assessing comprehension, identifying knowledge gaps, and scaffolding new concepts. In the online context, this demands the adoption of deliberate and proactive instructional strategies, including the establishment of clear expectations and the promotion of active participation. This may involve frequent questioning, structured peer interactions, and the use of digital tools to simulate the dynamics of a traditional classroom setting. Ultimately, cultivating constructive attitudes among students and fostering adaptive teaching approaches among instructors are fundamental to enhancing the quality and effectiveness of online learning.

Empirical Questions

Following the presentation of the research on this topic, several critical questions remain to be explored:

1. What is the relationship between students' perceptions of instructor effectiveness in online courses and their overall satisfaction with the learning experience?
2. How does the accessibility of online course materials influence students' academic success within virtual learning environments?
3. To what extent does online learning foster improved time management skills compared to traditional face-to-face instruction?
4. In what ways does the inherent flexibility of online learning affect students' academic performance?
5. Although not the primary focus of this study, it is also important to consider how the user-friendliness of online learning platforms influences student engagement and academic outcomes.

These questions highlight important dimensions of the online learning experience that warrant further empirical investigation to better understand their implications for educational practice and policy.

Data Analysis

Participants/Demographic

The study sample consisted of undergraduate students enrolled at a small Midwestern university. Surveys were distributed electronically via email, with a total of 40 participants completing the instrument. No external materials or specialized equipment were required for participation. Upon accessing the survey link, participants were first presented with an informed consent form. To proceed, individuals were required to indicate their consent by selecting either "I agree" or "I disagree." Participants who selected "I agree" were considered to have provided

informed consent and were subsequently directed to the demographic section of the survey. Those who selected "I disagree" were redirected to a page that thanked them for their time, and their participation was terminated. The consent form informed all participants of their right to withdraw from the study at any point without penalty. Completion of the survey required approximately two to five minutes.

Methodology

Data Collection/Procedures

The survey instrument was submitted to the Tiffin University Institutional Review Board (IRB) and received formal approval prior to data collection. Participant responses were compiled into a Microsoft Excel spreadsheet for analysis. Two statistical tests were conducted with a significance level set at $p < 0.05$. First, descriptive statistics were calculated to summarize the data. Second, a two-sample *t*-test assuming equal variances was conducted to assess potential differences between groups. The survey was organized into four primary categories, each comprising five items designed to measure students' perceptions within that domain. The first category, *Instructor & Course Delivery*, assessed the clarity, organization, and instructional effectiveness of the course and instructor. The second, *Engagement & Interaction*, evaluated student motivation, participation, and communication within the online learning environment. The third, *Learning Outcomes & Perceived Effectiveness*, focused on students' subjective evaluation of their academic progress and knowledge acquisition. The fourth category, *Technology & Resources*, addressed the accessibility, usability, and quality of technological tools and resources.

These four categories served as the independent variables in the study. Dependent variables included students' overall satisfaction, perceived effectiveness of the online learning experience, and self-reported academic performance. Responses to each survey item were measured using a five-point Likert scale. Participants could select from five options: *Strongly Disagree*, *Disagree*, *Neither Agree nor Disagree*, *Agree*, and *Strongly Agree*. Responses were scored on an inverted numerical scale, where *Strongly Disagree* received a score of 5 and *Strongly Agree* received a score of 1.

Results

Demographic Data

Statistical analyses revealed several significant group comparisons in the overall survey scores and across specific categories. For the total survey score, statistically significant differences emerged between *All Male* and *All Criminal Justice (CJ)* students, as well as between *Male Non-Criminal Justice (NCJ)* and *Female CJ*

students. Within the *Instructor & Course Delivery* category, significant differences were observed between *All Male* and *All Female* participants, as well as between *All Male* and *All CJ* groups. In the *Technology & Resources* category, multiple comparisons yielded statistically significant differences. These included: *All Male* vs. *All Female*, *All Male* vs. *All CJ*, *All Female* vs. *All NCJ*, *All CJ* vs. *All NCJ*, *Male NCJ* vs. *Female CJ*, and *Male NCJ* vs. *Female NCJ*. In contrast, no statistically significant differences were found among any group comparisons in the categories of *Engagement & Interaction* and *Learning Outcomes & Perceived Effectiveness*.

Data Analysis

An analysis of the Likert-scale survey data revealed that higher numerical scores indicated more negative perceptions or attitudes toward online learning, while lower scores reflected more positive evaluations. The composite score for the entire survey ranged from a minimum of 20 to a maximum of 100. Each of the four measured categories—*Instructor & Course Delivery*, *Engagement & Interaction*, *Learning Outcomes & Perceived Effectiveness*, and *Technology & Resources*—had possible score ranges from 5 to 25. Two statistically significant comparisons emerged from the total composite scores.

The first significant comparison, illustrated in Figure 1, was between all male participants and all criminal justice majors. The results yielded a t-value of 2.13 and a p-value of 0.03, with mean scores of 56.45 and 47.48, respectively. These results suggest that criminal justice majors held significantly more positive perceptions of online learning than male students overall. The second significant comparison, shown in Figure 4, compared male non-criminal justice students to female criminal justice students, resulting in $t = 2.22$ and $p = 0.03$. The mean for male non-criminal justice students was 59.00, while the mean for female criminal justice students was 46.69, indicating that female criminal justice students perceived online learning more positively.

In the *Instructor & Course Delivery* category, two statistically significant differences were observed. Figure 5 depicts the comparison between all male and all female participants, with $t = 2.18$ and $p = 0.03$. The mean score for males was 14.09, while females scored 11.10, suggesting that female students reported feeling more engaged and comfortable with online course delivery. Figure 6 compares all males to all criminal justice majors, resulting in $t = 2.06$ and $p = 0.04$. The mean scores were 14.09 (males) and 11.37 (criminal justice), indicating that criminal justice majors were more positively disposed toward online instructional quality and engagement. These findings underscore the critical importance of user-friendly, accessible, and reliable technological platforms in supporting effective online education. Technology-related challenges can undermine even the most pedagogically sound online courses, directly impacting students' ability to engage with and benefit from digital instruction.

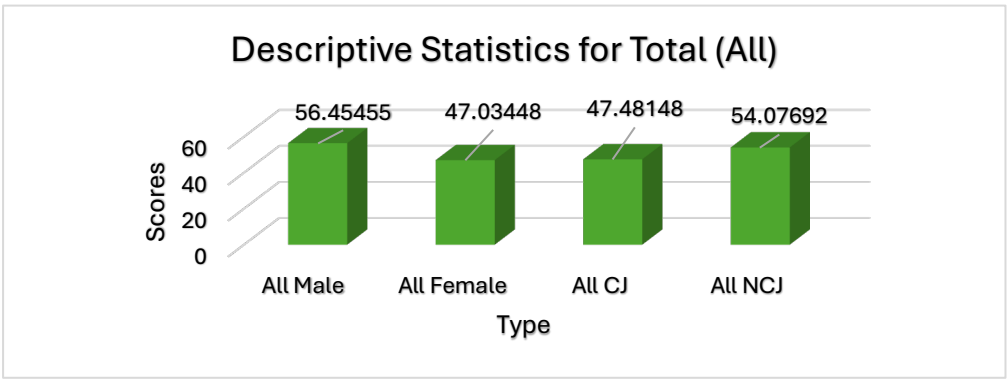

Figure 1. Descriptive statistics for all participants and the entirety of the survey (N=40)

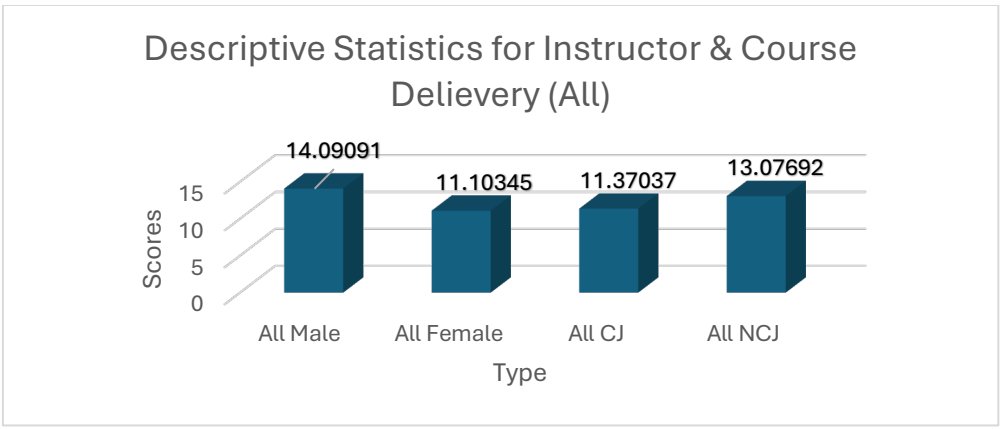

Figure 2. Descriptive statistics for all participants within the instructor and course delivery section (N=40)

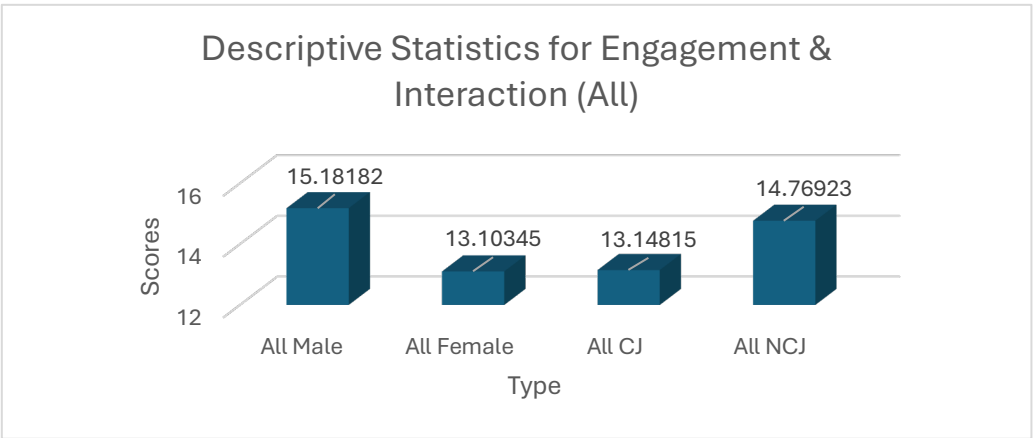

Figure 3. Descriptive statistics for all participants within the engagement and interaction section (N=40)

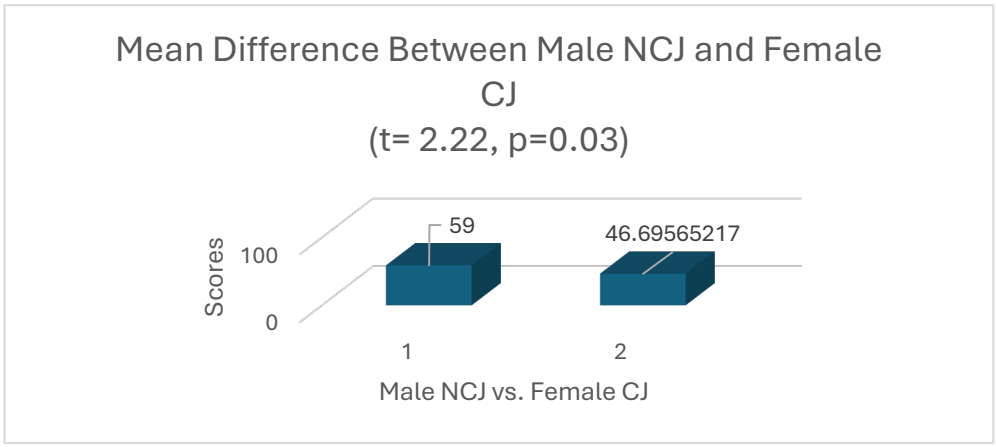

Figure 4. Mean between all male non-criminal justice and all female criminal justice within the entirety of the survey (N=40)

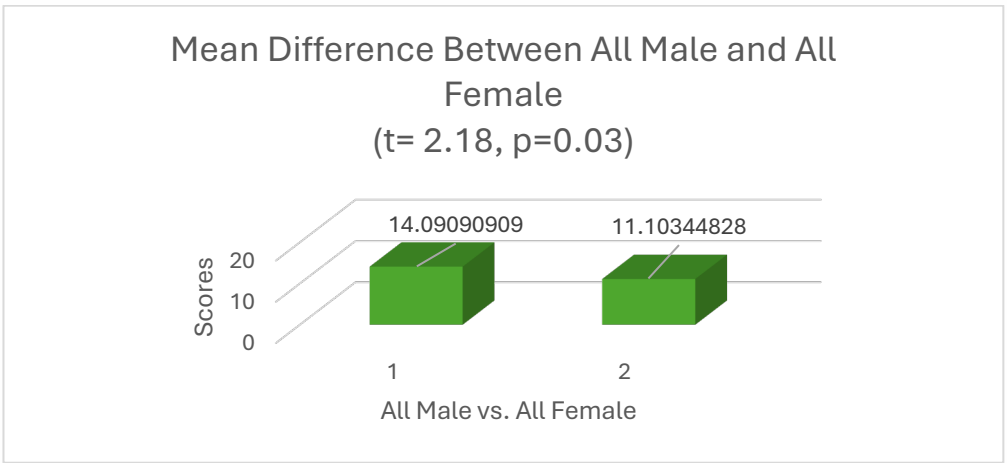

Figure 5. Mean between all male and all female within the entirety of the survey (N=40)

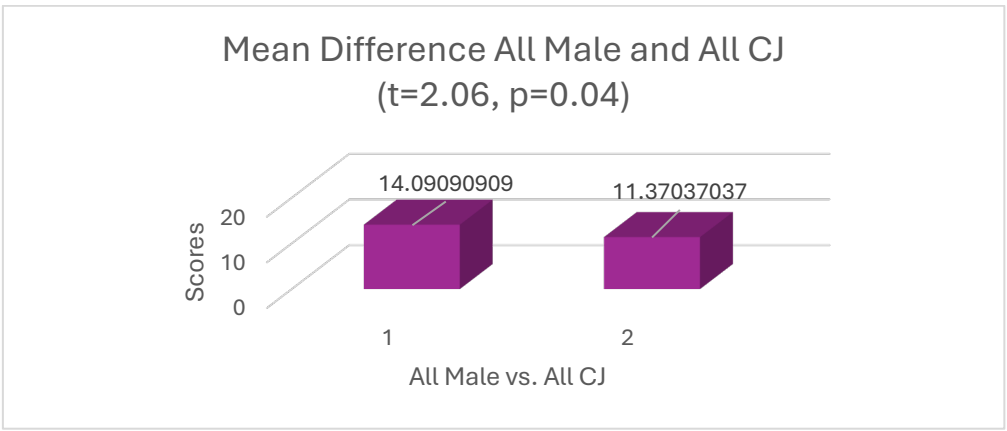

Figure 6. Means between all males to all criminal justice majors within the instructor and course delivery category (N=40)

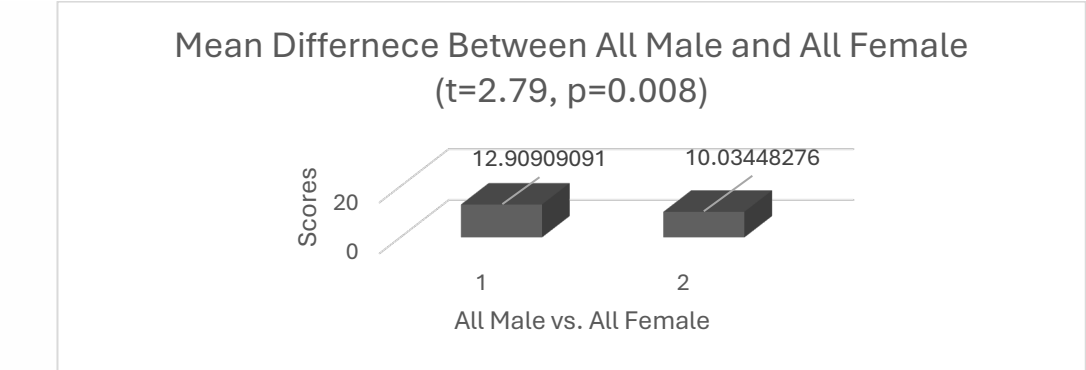

Figure 7. Mean between all male and all female in the technology and resources category (N=40)

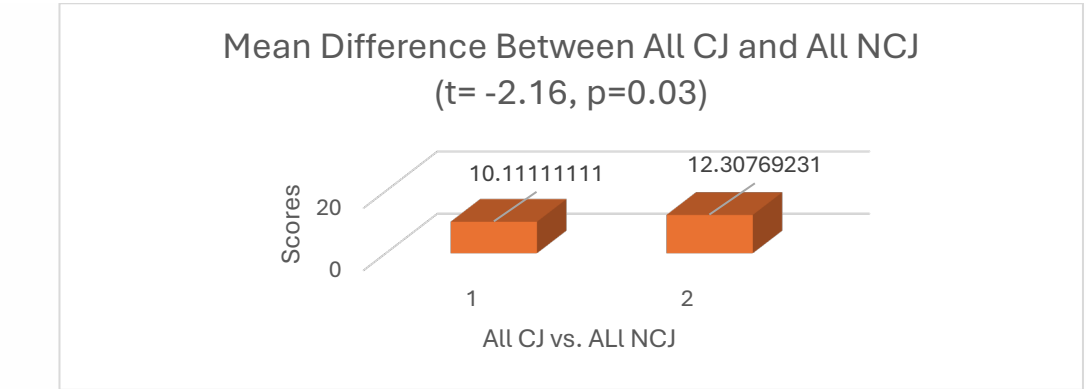

Figure 8. Mean between all criminal justice and all non-criminal justice within the technology and resource category (N=40)

Limitations

This study is subject to several limitations that may affect the quality, reliability, and generalizability of its findings. Foremost among these is the relatively small sample size, which limits statistical power and increases the risk of Type I and Type II errors. A smaller sample may also fail to adequately capture the diversity of the broader student population in terms of age, academic status, and cultural background. In this case, the majority of respondents were between 20 and 22 years old, identified as Caucasian/White, and held graduate-level academic standing, potentially skewing the results. Additionally, the geographic and institutional scope of the study was narrow, as data were collected exclusively from students at a single Midwestern university. This localized sampling limits the applicability of the findings to students in other regions or types of institutions, where educational experiences and cultural contexts may differ significantly. The use of self-reported data introduces further limitations, as responses may be influenced by recall errors, misinterpretation of survey items, or social desirability bias. The voluntary nature of participation also raises the possibility of selection

bias, as individuals with strong opinions about online learning may have been more motivated to respond. Collectively, these limitations constrain both the internal and external validity of the study, indicating that the results should be interpreted with caution and may not be representative of the broader student population.

Discussion

The results of this study indicate that both gender and academic major play important roles in shaping student perceptions of online learning. Female students reported higher levels of comfort and engagement with online courses compared to male students, which supports existing research suggesting that students from younger generations, particularly women, may be more adaptable to digital platforms and technologies (Harrison & McTavish, 2026; Nurul et al., 2020). This could be due to increased familiarity with online communication tools, stronger self-regulation skills, or a greater appreciation for the flexibility that online courses offer. These findings align with previous literature suggesting that student attitudes, especially motivation and self-discipline, are critical to the success of virtual education (Datnow, 2020).

Criminal justice majors, especially females within the discipline, also perceived online learning more positively than students from other majors. This may reflect the structured nature of criminal justice programs, which often emphasize discipline, clear expectations, and independent work- traits that translate well into virtual learning environments (Loeb, 2025; Hussin, 2017). These findings suggest that certain academic programs may better prepare students for the demands of online learning or that their course structures are more easily adapted to digital platforms. However, it is important to acknowledge that online learning is not universally effective for all students. The variation in perceptions reinforces the need for institutions to tailor online course design to different student populations and support needs, particularly for male students and those in less structured academic fields. Future research could further investigate how course content, instructional style, and student support systems interact with demographic factors to influence online learning outcomes.

Conclusion and Future Scope

The analysis indicates significant variation in students' perceptions of online learning based on both gender and academic major, particularly within the areas of instructor effectiveness, course delivery, and technological accessibility. These findings offer initial insights into several of the research questions underpinning this study. For example, more favorable perceptions reported by female students and criminal justice majors in the *Instructor & Course Delivery* category suggest a potential link between students' evaluations of instructional quality and their overall satisfaction with online learning environments. Similarly, the consistent

gender-based differences observed in the *Technology & Resources* category—with female participants reporting higher levels of satisfaction—emphasize the critical influence of platform accessibility, user-friendliness, and technological infrastructure on student engagement and academic success.

Additionally, the relatively positive responses from female criminal justice majors may indicate a higher degree of digital fluency and adaptability, potentially contributing to more effective time management and greater participation in virtual coursework. While this study did not directly assess all proposed research questions—such as comparative analyses with traditional classroom settings or the development of time management skills—the results nonetheless highlight key considerations for the design and implementation of online learning environments. Specifically, the findings reinforce the importance of inclusive, accessible course structures, coupled with effective and responsive instruction, in fostering student engagement, motivation, and satisfaction in online education contexts.

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