International Journal of Education and Practice
2025 Vol. 13, No. 1, pp. 69-80
ISSN(e): 2310-3868
ISSN(p): 2311-6897
DOI: 10.18488/61.v13i1.3944

The relationships between online program formatting, technology satisfaction, and course quality

Ahmed Alsayer
Taibah University, Medina, Saudi Arabia.
Email: alsayerah@gmail.com

Article History
Received: 22 May 2024
Revised: 26 September 2024
Accepted: 14 October 2024
Published: 24 October 2024

Keywords
Blended courses
Course quality
Online education
Scale validation
Student satisfaction.

ABSTRACT

This study aims to explore students' perceived quality of graduate courses in relation to their satisfaction with the technological tools used in online master's level courses. Invariance testing and structural equation modelling were used to demonstrate the validity of technology usage scales and effectively test links between course type, technology satisfaction, and course quality. The study participants included 364 graduate students enrolled at a large university in the Midwest who were taking blended and fully online courses. The participants responded to a scale regarding their experience with the course. Interestingly, program type (blended vs. fully online) did not significantly impact technology satisfaction or the perceived quality of the course, even after taking into account the technology satisfaction mediator on course quality. Program type is not related to course quality, although technology satisfaction does contribute to quality ratings. The implications for instructors suggest that the development of technology-centric activities is warranted to improve the quality of online education courses.

Contribution/Originality: The current research empirically investigated the link between course type (online vs. blended) on course quality. The findings show no significant relationship but implicate technology satisfaction as a key contributor to students' perceptions of online courses.

1. INTRODUCTION

The COVID-19 pandemic brought about unprecedented changes in many areas of our lives, but one of the most profoundly affected areas was education. Before the pandemic, higher education institutions and K-12 schools had the choice of delivering courses in face-to-face, blended, or fully online formats. Given the fact that schools could not reasonably control all student interactions in addition to the minimum required physical separation of at least one meter distance (World Health Organization, 2020), attending school in person became nearly impossible for many students. In fact, the number of learners who could not attend school because of the pandemic reached 1.5 billion students (UNESCO, 2020) in over 188 countries (OECD, 2022). The sudden shift to virtual learning forced millions of students and teachers to discover new online learning platforms and resources, which were very different from face-to-face education (Cui et al., 2023). Though learning losses occurred worldwide (OECD, 2023), the new platforms which were developed should benefit education systems in the future.

Research is somewhat limited on how different online modalities and technological quality contributed to course quality reports. Although comparisons have been made between the course quality reports of fully online and in-person courses (e.g., (Allen, Bourhis, Burrell, & Mabry, 2002; Shachar & Neumann, 2010)), a comparison between

blended and fully-online courses is currently lacking. There is also a lack of clarity of variation in technology satisfaction that may account for the potential relationship between course type and course quality. This study aims to answer how master's degree students from different program types may vary in their perceived course quality, and if this potential link is explained by technology use satisfaction.

2. LITERATURE REVIEW

The change in learning policies due to the pandemic affected education courses both negatively and positively. Educational outcomes such as achievement scores (OECD, 2023) and other factors such as psychological traits, stress, and social connection were also affected (Tibbetts, Epstein-Shuman, Leitao, & Kushlev, 2021). For example, students who learn better through face-to-face interaction in social environments may have been affected negatively, as they were suddenly taken away from peers, group learning, and the direct instruction of their teachers (Chisadza, Clance, Mthembu, Nicholls, & Yitbarek, 2021). In contrast, students who learn better individually in a more isolated environment with little distraction may have been positively affected. A long-term improvement for student learning could emerge from the availability of new educational sources and educational technology tools which occurred during the pandemic (Garfin, 2020). New learning sites and online tools were developed, which included sites that offered math, spelling, and grammar help. Despite the new tools and websites that were available to students and teachers, according to international assessment organization reports (such as the International Association for the Evaluation of Educational Achievement and the Organization for Economic Co-operation and Development), most countries that went virtual saw a *decrease* in achievement scores during the pandemic. For example, the OECD's average and specific metrics from other countries (Costa Rica, Colombia, Albania, Colombia) showed decreases in all three subject areas from the 2018 cycle to the 2022 cycle (using the OECD as an example, the mathematics mean score decreased by 15 points, science mean scores decreased by 10 points, and reading mean scores decreased by 2 points). On the other hand, several countries saw an increase in scores during the same period (e.g., Panama, Dominican Republic, Paraguay) OECD (2023).

There have been many recent changes in the education system that occurred for multiple reasons (e.g., the pandemic, the development of artificial intelligence, and technology development in general (see (Alsayer & Lowenthal, 2024)). These sudden shifts in education format have altered how online courses are delivered, affecting students' preferences and satisfaction with online courses (Baker, Unni, Kerr-Sims, & Marquis, 2020; Kang & Park, 2022). These recent changes have also influenced how students and teachers perceive online courses and how the courses are delivered (MacArthur, Stacey, Harvey, & Markle, 2021; Spencer & Temple, 2021).

2.1. Student Preferences in Education Format (Program/Course Type)

Students' perceptions of online course quality can lead to unfavorable education outcomes, such as low levels of motivation, which can affect overall performance and satisfaction in educational settings (Zizka & Probst, 2023). However, the "one size fits all" approach may not work well for different student circumstances (Kauffman, 2015). Iglesias-Pradas, Hernández-García, Chaparro-Peláez, and Prieto (2021) found that students' overall performance in online courses was significantly higher than their counterparts in face-to-face education. While some students prefer face-to-face interaction, others may prefer entirely online courses, and others may prefer blended learning courses depending on their circumstances and characteristics (Larson, Davies, Steadman, & Cheng, 2023). Not only did students' preferences differ regarding online, blended, and traditional courses, but their performance scores also differed. The United States Department of Education conducted a meta-analysis, and the results revealed that students who took fully online or blended courses scored higher in midterms and final exams (Kauffman, 2015).

Researchers have identified negative experiences (e.g., lack of socialization, lack of social presence, and information overload) and positive experiences (e.g., time and location flexibility, digital literacy, interpersonal skills, and project planning) with online courses (Al-Mawee, Kwayu, & Gharaibeh, 2021; Alsayer, 2023) and current

research has shown that the variation in preferences is due to a myriad of reasonings (Baker et al., 2020; Dahlstrom-Hakki, Alstad, & Banerjee, 2020). According to Gherheş, Stoian, Fărcaşiu, and Stanici (2021) most of the students preferred face-to-face courses (27.2%) over e-learning courses (13.9%). Those who preferred e-learning courses reported that the main advantages of online education were saving time by not having to commute to school and the comfort of staying at home. Meulenbroeks (2020) found that the students who prefer offline meetings appreciated the higher amount of interaction. When using large-scale assessments to evaluate the preferences of thousands of students, researchers (e.g., Ruipérez-Valiente et al. (2022)) have found a wide array of differences among students in online settings. In summary, most studies investigated face-to-face versus online/e-learning formats. However, few recent quantitative studies have investigated the different types of e-learning formats, which can include entirely online course delivery or a type of blended learning approach (e.g., (Asarta & Schmidt, 2020; Quinn & Aarão, 2020)). This lack of clarity is one of the current research gaps being addressed by this study.

2.2. Course Quality

The design of online courses should begin with a blueprint. Certain items should be checked before a course is considered complete and of a high quality (Zimmerman, Altman, Simunich, Shattuck, & Burch, 2020). When looking at the assessment literature on the quality of designing online courses, one can see that there could be three primary sources: Quality matters (i.e., (Taylor, Roehrich, & Grabanski, 2018; Zimmerman et al., 2020)), students' perspective scale items, such as the Community of Inquiry Framework (Alanazi, 2019; Garrison, Anderson, & Archer, 1999) and a checklist of items to examine the quality of online courses (e.g., (McGahan, Jackson, & Premer, 2015; Murillo & Jones, 2020; Ralston-Berg, Buckenmeyer, Barczyk, & Hixon, 2015)).

Although there are other informal sources for rating courses, such as the RateMyProfessors.com website, these sources are often criticized for their validity (Cavanaugh, Jacquemin, & Junker, 2023). Many factors affect students' perceptions of online course quality, and this is important because the level of student satisfaction with courses is directly related to academic performance (Zeng & Wang, 2021). The presence of instructors is often a significant factor in whether a course is considered high quality, and a greater sense of presence shows increased student engagement and satisfaction (Zimmerman et al., 2020). How the course is designed, the course materials, the digital learning activities and resources, and the instructor's ability to explain the purpose of the activities all play a significant part in how students view the quality of their courses (Zimmerman et al., 2020). In other words, if students can see the relevance of the activities and projects they were assigned, feel like they were able to engage with the teacher and their peers, and can see their progress, they're more likely to view the course as being of high quality. While there is much current work on course quality, one of the other research gaps is that the variation in course quality with online components has not been sufficiently explored with regard to different types of online course delivery.

2.3. Technology Satisfaction

There are multiple models which can help explain technology satisfaction, such as the Technology Satisfaction Model Islam (2014) and the Technology Acceptance Model Marangunić and Granić (2015) and how learners' satisfaction with technology affects their performance (Alanazi et al., 2020). Technology satisfaction is an important factor affecting many online environments (Jiang, Islam, Gu, & Spector, 2021; Shonfeld & Magen-Nagar, 2020). One key factor that can affect whether a student is satisfied with their use of technology is whether or not they are able to collaborate with others and with their teacher. The ability to collaborate has been shown to increase students' sense of belonging and motivate students to participate (Shonfeld & Magen-Nagar, 2020). On the contrary, students who experience a phobia of technology or do not feel confident using technology tend to show lower satisfaction levels with the online program or the technology aspect (Shonfeld & Magen-Nagar, 2020), suggesting a direct link between technological satisfaction and satisfaction with the course overall. Importantly,

Shonfeld and Magen-Nagar (2020) found that blended learning students reported lower satisfaction with technology compared to those who were enrolled in a fully remote class. The research gap to test for differences between blended and fully online courses has not been assessed with regard to technology satisfaction.

As a final note regarding measures to evaluate course quality, some researchers use rubrics with specific standards, such as Quality Matter (i.e., (Taylor et al., 2018; Zimmerman et al., 2020)) although there are marked differences in how to assess courses and, therefore, make judgments about the important predictors of course quality. Given this, it is also important to ensure that the scales used to assess technology satisfaction and course quality are effectively designed and validated.

2.4. Research Gaps and Current Goals

From past literature, it is clear that there is considerable variability in course quality reports (e.g., (McGahan et al., 2015; Murillo & Jones, 2020; Ralston-Berg et al., 2015)) and that part of this variability may be due to the many reasons why students prefer either online or in-person courses (Meulenbroeks, 2020; Ruipérez-Valiente et al., 2022). However, work which unifies these two effects, perhaps through the critical technology satisfaction needed for success in today's courses (Jiang et al., 2021; Shonfeld & Magen-Nagar, 2020) has yet to be conducted.

The current study attempts to address this gap in the literature by investigating the effect of program type (blended vs. fully online) on course quality and the effect of program type on course quality through technology satisfaction. These relationships will be assessed after validation testing of the scales being used to ensure that relationships are based on measures high in construct validity. Potential results will provide insight into the mechanisms contributing to perceived course quality and satisfaction in online settings which emerged predominately during the COVID-19 pandemic. More specifically, the study addresses the following research questions:

2.5. Research Questions

- To what extent does technology satisfaction affect course quality?
- Is there a statistically significant difference between program type based on course quality when holding technology satisfaction constant?
- Is there a statistically significant difference between different program types that are based on technology satisfaction?
- What is the indirect effect of program type on course quality through technology satisfaction?
- What is the total effect of program type and technology satisfaction on course quality?

3. METHODOLOGY

3.1. Research Population

The current study selected 364 higher education master's students enrolled at the University of Kansas, a large midwestern university in the United States, to capture a representative sample of the higher education population. There were 170 (46.70%) male and 194 (53.29%) female participants. Out of the 364 participants, 158 (43.40%) took fully online courses and 206 (56.60%) took blended courses (both online sessions and face-to-face meetings). The average age of the participants was 26.78 (SD = 2.65). Prior to the data collection procedure, the Ethical Committee of the University of Kansas granted approval for this study.

3.2. Research Design

Participants completed a brief 12-item survey using a five-point Likert scale, which assessed demographics, course quality, and technology satisfaction. This model for the study will use structural equation modeling (SEM) with latent factors for course quality and technology satisfaction. The course quality scale included four items, and

the technology satisfaction scale included five items. The relationships modeled links between the program type (i.e., fully online or blended), technology satisfaction, and course quality. The survey link was posted online, and instructors asked their students to participate in the study.

3.3. Instrument

The complete survey comprised 12 items (see Appendix 1) and used a five-point Likert scale, ranging from Strongly Disagree (1) to Strongly Agree (5). In addition to the scale items, there were items asking about the program type, the participant's age, and the participant's gender.

3.4. Validity

Two-item factor analysis models were used to examine the validity of the two constructs: course quality and technology satisfaction. For each construct scale, invariance testing was conducted: *configural invariance* to examine the equivalence of the form, *metric invariance* to examine the equivalence of the factor loadings, and *scalar invariance* to examine the equivalence of intercepts (Dong & Dumas, 2020; Leitgöb et al., 2023; Van de Schoot, Lugtig, & Hox, 2012).

To make sure that the measurement model fitness met the standard fit indices, the criteria were as follows: The root mean square error of approximation (RMSEA) value should range from 0.00 to 0.08 (a value closer to 0.00 indicates a better fit), the standardized root mean squared residual (SRMR) values should range from 0.00 to 0.05 (a value closer to 0.00 indicates a better fit), the comparative fit index (CFI) value should range from 0.95 to 1.00 (a value closer to 1.00 indicates a better fit), and the Tucker–Lewis Index (TLI) value should range from 0.95 to 1.00 (a value closer to 1.00 indicates a better fit) Hu and Bentler (1999).

3.5. Reliability Estimates

This study utilized a structural equation modeling (SEM) approach to investigate the direct and indirect effects of the variables of interest (see Figure 1). SEM is an appropriate method for the model since there are latent constructs in the model to examine both direct and indirect effects (Hair Jr et al., 2021; MacArthur et al., 2021). SEM analyzes the relationships of psychological constructs with less measurement error (Nachtigall, Kroehne, Funke, & Steyer, 2003) and is widely used to test complex models involving several dependent and independent variables (MacCallum & Austin, 2000). By combining the essence of factor analysis in conjunction with SEM, one can see the potential structural relationships that exist between the different variables or, in this case, the use of fully online learning or blended learning, course quality, and technology satisfaction.

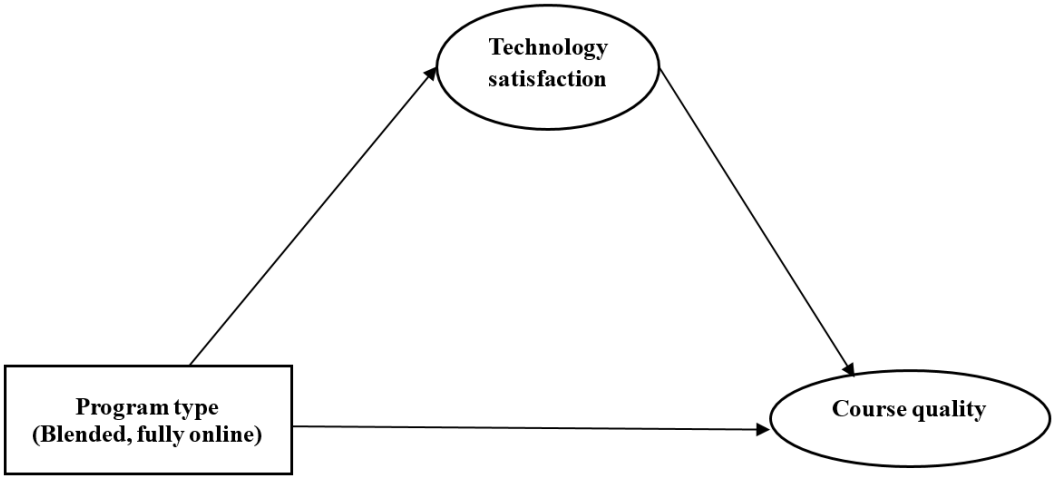

Figure 1. Course quality, technology satisfaction, and program type model.

4. RESULTS

4.1. Course Quality Measurement Model

To ensure that the course quality scale measures the same construct between the two groups (i.e., fully online format vs. blended format), the scale was analyzed using measurement invariance. The fit indices of the course quality scale model indicate that the configural model appropriately fits as follows: CFI value = 1.000, TLI value = 1.040, RMSEA value = 0.000, and SRMR value = 0.006. Since the configural model fit indices indicated an appropriate fit according to the criteria, the metric model was conducted. The results of the metric model fit indices are as follows: CFI value = 1.000, TLI value = 1.023, RMSEA value = 0.000, and SRMR value = 0.035. Then a scalar model was conducted, and the results are as follows: CFI value = 1.000, TLI value = 1.000, RMSEA value = 0.004, and SRMR value = 0.044. The reliability estimate was calculated using the Omega equation and produced a value of 0.84 (see Table 1).

4.2. Measurement Model for Technology Satisfaction

The fit indices of the technology satisfaction model for the configural model indicate an appropriate fit as follows: CFI value = 0.997, TLI value = 0.992, RMSEA value = 0.042, and SRMR value = 0.024. Since the configural model fit indices indicated an appropriate fit according to the criteria, the metric model was conducted, and the results of the fit indices are as follows: CFI value = 0.995, TLI value = 0.991, RMSEA value = 0.043, and SRMR value = 0.034. Finally, a scalar model was conducted, and the results are as follows: CFI value = 0.986, TLI value = 0.982, RMSEA value = 0.061, SRMR value = 0.051. The reliability estimate was calculated using the Omega equation, resulting in a value of 0.80 (see Table 1).

Table 1. Fit indices for invariance measurement models.

Scale	Model	CFI	TLI	RMSEA	SRMR	Chi sq.	df
Course quality	Configural	1.000	1.040	0.000	0.006	1.125	4
	Metric	1.000	1.023	0.000	0.035	5.049	7
	Scalar	1.000	1.000	0.004	0.044	15.415	10
Technology satisfaction	Configural	0.997	0.992	0.042	0.024	15.012	8
	Metric	0.995	0.991	0.043	0.034	21.463	12
	Scalar	0.986	0.982	0.061	0.051	32.267	16

4.3. Statistical Model

To examine the research questions stated above, SEM was carried out to examine the fit of the factors in the model. The results of the SEM indicated that the overall model fits well according to the indices as follows: CFI value = 0.988, TLI value = 0.987, RMSEA value = 0.077, SRMR value = 0.044, and χ^2 (32) = 57.271.

The results of the course quality measurement and the technology satisfaction measurement were calculated using measurement invariance and the scalar model to ensure that the results would be reflected accurately, as illustrated in Table 1. The results of the first research question indicated that for a one standard deviation increase in technology satisfaction, a half standard deviation increase in course quality is expected (β = 0.497, $p < 0.001$), which is statistically significant at an alpha level of 0.05. The results of the second research question indicated that blended learning participants perceive a lower course quality than fully online participants (β = -0.112, p = 0.038), which is a statistically significant difference. The results of the third research question indicated that blended learning participants perceive slightly higher technology satisfaction than fully online participants (β = 0.076, p = 0.199); however, the difference between the two groups is not statistically significant. The results of the fourth research question indicated that the indirect effect of program type on course quality through technology satisfaction (β = 0.038, p = 0.203) was not statistically significant. In other words, technology satisfaction was not found to mediate the relationship between program type and course quality. The results of the fifth research

question indicated that the total effect of program type and technology satisfaction on course quality was negative (β = -0.074, p = 0.204) but not statistically significant.

Figure 2 illustrates the indirect program type on course quality through technology satisfaction.

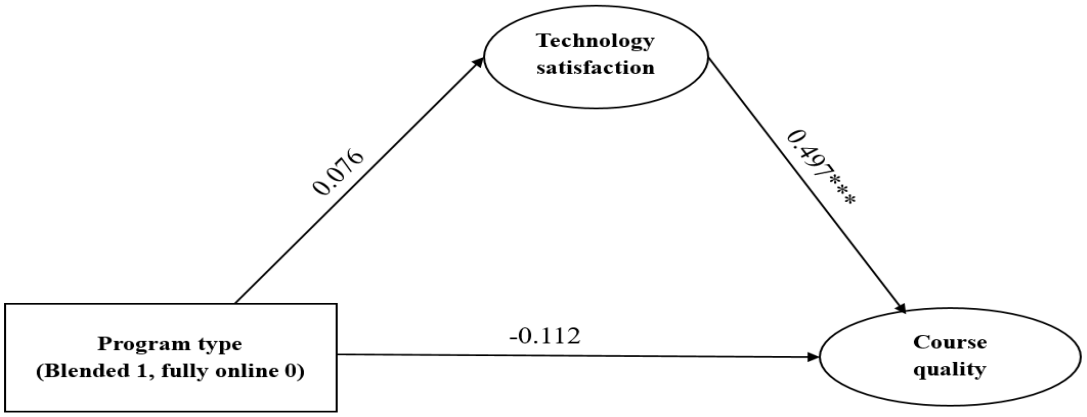

Figure 2. Course quality, technology satisfaction, and program type model results.

Note: *** p < 0.05.

5. DISCUSSION

This study investigated the direct and indirect effects of program type and technology satisfaction on course quality in blended and fully online learning environments. The results of the measurement models indicate that this research validates the items of the two latent construct scales used in this study, *course quality* and *technology satisfaction*. Through using multiple measurement models within an invariance testing framework (i.e., configural model, metric model, and scalar model), the results of the two scales showed appropriate fit indices according to the fit criteria (Alsayer, Templin, Niileksela, & Frey, 2024; MacArthur et al., 2021). Thus, the study provides appropriate standard criteria for both the validity and the reliability estimates for the two scales. In addition, the results of this research support that students' satisfaction with the use of technology (accessing the platforms, websites, ease of use, etc.) is a statistically significant predictor of their level of perception of the quality of the course they are taking (Ho, Cheong, & Weldon, 2021). In other words, the more satisfied students are with the technological tools in educational environments, the higher their level of perceived quality of the course. Thus, one would expect a higher level of performance in well-designed online learning environments (Alanazi et al., 2020; Serrano, Dea-Ayuela, Gonzalez-Burgos, Serrano-Gil, & Lalatsa, 2019).

The results of the statistical SEM model also indicate that students who are taking fully online courses perceived higher course quality than blended learning when holding technology satisfaction constant. However, the blended learning participants had slightly higher technology satisfaction than online participants, and while this impact is not statistically significant by itself, it is large enough to render the overall impact of program type on course quality statistically indeterminate (Arain et al., 2022). Looking at the items on the course quality scale, one would expect less bias toward either group (fully online, blended) because the items of the course quality scale focus on the quality of the course rather than incorporating course format. Although students have different preferences for course format, this study indicates a lower level of perceived course quality among blended learning participants. In other words, students who take blended learning courses tend to be more satisfied with the use of technology than those who take fully online courses. Even though program type does not explain a meaningful portion of the variance in technology satisfaction, program type explains a great amount of the variability in the quality of online courses (Wright, Volodarsky, Hecht, & Saxe, 2023). Higher technology satisfaction resulted in higher course quality satisfaction, and students who participated in blended learning perceived their course quality to be significantly lower than those participating in fully online courses when holding technology satisfaction

constant, but not when using technology satisfaction as a mediator due to indeterminately higher technology satisfaction in blended courses.

6. IMPLICATIONS FOR ONLINE INSTRUCTORS

As more schools offer online programs, this study will benefit online instructors. While instructors do not always have control over the type of technology that is accessible to all students taking their classes, instructors can take precautions to ensure their course is of high quality by looking at the course blueprint. This study suggests that it is imperative for online instructors to plan activities and lessons that clearly show students the relevance of each activity (Murillo & Jones, 2020). Online instructors can also take note of the results, which will indicate to students that the instructor is accessible and present. Online instructors might consider making an introductory video or presentation, or even recording some lessons or lectures to upload to the online platform so that students feel as if they are interacting with a person instead of simply being placed in front of their computer.

To ensure that lessons or lectures are engaging, it is imperative that faculties include interactive approaches, so learners are engaged with teaching and learning activities (Arain et al., 2022). Therefore, courses should include formative assessments and feedback, but should also include more engaging material to support students' connection with the course. Dietrich et al. (2020) reported that students retained significantly more information when presented with it online as opposed to a traditional classroom setting, and this may be because students are able to go back and review the content as often as they want and have the ability to work at their own pace—it also allows students to approach the professor when questions arise. For this reason, having a solid communication medium established was duly noted (Dietrich et al., 2020). Furthermore, the use of augmented reality or virtual reality were indicated to further improve the experience associated with online learning. As a result of these various components, schools have made major changes in response to the challenges posed by the COVID-19 pandemic.

7. CONCLUSION

The unprecedented spread of COVID-19 forced many schools across the world to quickly shift from mostly in-person learning to online learning. This shift at first appeared to be problematic because of the sudden lack of socialization for students, an abrupt switch from in-person learning to remote learning, and the bombardment of new software and online programs. As time passed, it became apparent that the abrupt switch had several benefits, some of which resulted in new learning platforms becoming quickly available to students and innovative instructional techniques being adapted by classroom teachers and professors. The current study found that course type (blended vs. fully online) was not related to course quality variation, but technology satisfaction was a significant predictor of course quality. Overall, this study shows that whether a course is blended or fully online matters much less for perceived course quality than the level of technology satisfaction—in fact, a one standard deviation increase in technology satisfaction was linked with a 0.497 standard deviation increase in course quality, which is a large and impressive effect. These findings suggest that focusing efforts on students' technological satisfaction, perhaps through the development of effective online tools and collaborative online programming, can help to promote smoother course delivery and, ultimately, higher student satisfaction. This research provides further impetus for educators to pursue novel course design strategies and to learn more about the implementation of online tools in their classrooms.

Funding: This study received no specific financial support.
Institutional Review Board Statement: The Ethical Committee of the University of Kansas, United States has granted approval for this study on 6 September 2019 (Ref. No. STUDY00004225).
Transparency: The author states that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
Competing Interests: The authors declare that they have no competing interests.

REFERENCES

Al-Mawee, W., Kwayu, K. M., & Gharaibeh, T. (2021). Student's perspective on distance learning during COVID-19 pandemic: A case study of Western Michigan University, United States. *International Journal of Educational Research Open*, *2*, 100080. https://doi.org/10.1016/j.ijedro.2021.100080

Alanazi, A. A. (2019). *Online learning environments: Investigating the factors influencing social presence doctoral dissertation, University of Kansas*. Retrieved from https://kuscholarworks.ku.edu/bitstream/handle/1808/30232/Alanazi_ku_0099D_16912_DATA_1.pdf?sequence=1&isAllowed=n

Alanazi, A. A., Frey, B. B., Niileksela, C., Lee, S. W., Nong, A., & Alharbi, F. (2020). The role of task value and technology satisfaction in student performance in graduate-level online courses. *TechTrends*, *64*(6), 922-930. https://doi.org/10.1007/s11528-020-00501-8

Allen, M., Bourhis, J., Burrell, N., & Mabry, E. (2002). Comparing student satisfaction with distance education to traditional classrooms in higher education: A meta-analysis. *The American Journal of Distance Education*, *16*(2), 83-97. https://doi.org/10.1207/S15389286AJDE1602_3

Alsayer, A. A. (2023). Learners' experiences in an online learning environment: An analysis of the impact of international collaboration. *SAGE Open*, *13*(4), 1-15. https://doi.org/10.1177/21582440231208524

Alsayer, A. A., & Lowenthal, P. R. (2024). Measuring social presence in online learning: A validation study. *Education and Information Technologies*, 1-22. https://doi.org/10.1007/s10639-024-12972-w

Alsayer, A. A., Templin, J., Niileksela, C., & Frey, B. B. (2024). Examining the structure of the revised community of inquiry framework: A multi-level approach. *Education and Information Technologies*, 1-23. https://doi.org/10.1007/s10639-024-13090-3

Arain, S. A., Ali, M., Arbili, L., Ikram, M. F., Kashir, J., Omair, A., & Meo, S. A. (2022). Medical students and faculty perceptions about online learning during COVID-19 pandemic: Alfaisal University experience. *Frontiers in Public Health*, *10*, 880835. https://doi.org/10.3389/fpubh.2022.880835

Asarta, C. J., & Schmidt, J. R. (2020). The effects of online and blended experience on outcomes in a blended learning environment. *The Internet and Higher Education*, *44*, 100708. https://doi.org/10.1016/j.iheduc.2019.100708

Baker, D. M. A., Unni, R., Kerr-Sims, S., & Marquis, G. (2020). Understanding factors that influence attitude and preference for hybrid course formats. *E-Journal of Business Education and Scholarship of Teaching*, *14*(1), 174-188.

Cavanaugh, J., Jacquemin, S. J., & Junker, C. R. (2023). Variation in student perceptions of higher education course quality and difficulty as a result of widespread implementation of online education during the COVID-19 pandemic. *Technology, Knowledge and Learning*, *28*(4), 1787-1802. https://doi.org/10.1007/s10758-022-09596-9

Chisadza, C., Clance, M., Mthembu, T., Nicholls, N., & Yitbarek, E. (2021). Online and face-to-face learning: Evidence from students' performance during the Covid-19 pandemic. *African Development Review*, *33*, S114-S125. https://doi.org/10.1111/1467-8268.12520

Cui, Y., Ma, Z., Wang, L., Yang, A., Liu, Q., Kong, S., & Wang, H. (2023). A survey on big data-enabled innovative online education systems during the COVID-19 pandemic. *Journal of Innovation & Knowledge*, *8*(1), 100295. https://doi.org/10.1016/j.jik.2022.100295

Dahlstrom-Hakki, I., Alstad, Z., & Banerjee, M. (2020). Comparing synchronous and asynchronous online discussions for students with disabilities: The impact of social presence. *Computers & Education*, *150*, 103842. https://doi.org/10.1016/j.compedu.2020.103842

Dietrich, N., Kentheswaran, K., Ahmadi, A., Teychené, J., Bessière, Y., & Hébrard, G. (2020). Attempts, successes, and failures of distance learning in the time of COVID-19. *Journal of Chemical Education*, *97*(9), 2448–2457. https://doi.org/10.1021/acs.jchemed.0c00717

Dong, Y., & Dumas, D. (2020). Are personality measures valid for different populations? A systematic review of measurement invariance across cultures, gender, and age. *Personality and Individual Differences*, *160*(1), 109956. https://doi.org/10.1016/j.paid.2020.109956

Garfin, D. R. (2020). Technology as a coping tool during the coronavirus disease 2019 (COVID-19) pandemic: Implications and recommendations. *Stress and Health*, *36*(4), 555-559. https://doi.org/10.1002/smi.2975

Garrison, D. R., Anderson, T., & Archer, W. (1999). Critical inquiry in a text-based environment: Computer conferencing in higher education. *The Internet and Higher Education*, *2*(2-3), 87-105. https://doi.org/10.1016/s1096-7516(00)00016-6

Gherheş, V., Stoian, C. E., Fărcaşiu, M. A., & Stanici, M. (2021). E-learning vs. face-to-face learning: Analyzing students' preferences and behaviors. *Sustainability*, *13*(8), 1-15. https://doi.org/10.3390/su13084381

Hair Jr, J. F., Hult, G. T. M., Ringle, C. M., Sarstedt, M., Danks, N. P., & Ray, S. (2021). *Partial least squares structural equation modeling (PLS-SEM) using R: A workbook*: Springer Nature. https://doi.org/10.1007/978-3-030-80519-7.

Ho, I. M. K., Cheong, K. Y., & Weldon, A. (2021). Predicting student satisfaction of emergency remote learning in higher education during COVID-19 using machine learning techniques. *Plos One*, *16*(4), e0249423. https://doi.org/10.1371/journal.pone.0249423

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*, *6*(1), 1-55. https://doi.org/10.1080/10705519909540118

Iglesias-Pradas, S., Hernández-García, Á., Chaparro-Peláez, J., & Prieto, J. L. (2021). Emergency remote teaching and students' academic performance in higher education during the COVID-19 pandemic: A case study. *Computers in Human Behavior*, *119*(1), 106713. https://doi.org/10.1016/j.chb.2021.106713

Islam, A. A. (2014). Validation of the technology satisfaction model (TSM) developed in higher education: The application of structural equation modeling. *International Journal of Technology and Human Interaction*, *10*(3), 44-57. https://doi.org/10.4018/ijthi.2014070104

Jiang, H., Islam, A. A., Gu, X., & Spector, J. M. (2021). Online learning satisfaction in higher education during the COVID-19 pandemic: A regional comparison between Eastern and Western Chinese universities. *Education and Information Technologies*, *26*(6), 1-23. https://doi.org/10.1007/s10639-021-10519-x

Kang, D., & Park, M. J. (2022). Interaction and online courses for satisfactory university learning during the COVID-19 pandemic. *The International Journal of Management Education*, *20*(3), 100678. https://doi.org/10.1016/j.ijme.2022.100678

Kauffman, H. (2015). A review of predictive factors of student success in and satisfaction with online learning. *Research in Learning Technology*, *23*. https://doi.org/10.3402/rlt.v23.26507

Larson, M., Davies, R., Steadman, A., & Cheng, W. M. (2023). Student's choice: In-person, online, or on demand? A comparison of instructional modality preference and effectiveness. *Education Sciences*, *13*(9), 877. https://doi.org/10.3390/educsci13090877

Leitgöb, H., Seddig, D., Asparouhov, T., Behr, D., Davidov, E., De Roover, K., . . . Muthén, B. (2023). Measurement invariance in the social sciences: Historical development, methodological challenges, state of the art, and future perspectives. *Social Science Research*, *110*, 102805. https://doi.org/10.1016/j.ssresearch.2022.102805

MacArthur, K. R., Stacey, C. L., Harvey, S., & Markle, J. (2021). The direct and indirect effects of clinical empathy on well-being among pre-medical students: A structural equation model approach. *BMC Medical Education*, *21*, 1-11. https://doi.org/10.1186/s12909-021-02838-x

MacCallum, R. C., & Austin, J. T. (2000). Application of structural equation modeling in psychological research. *Annual Review of Psychology*, *51*, 201-226. https://doi.org/10.1146/annurev.psych.51.1.201

Marangunić, N., & Granić, A. (2015). Technology acceptance model: A literature review from 1986 to 2013. *Universal Access in the Information Society*, *14*(1), 81-95. https://doi.org/10.1007/s10209-014-0348-1

McGahan, S. J., Jackson, C. M., & Premer, K. (2015). Online course quality assurance: Development of a quality checklist. *InSight: A Journal of Scholarly Teaching*, *10*, 126-140. https://doi.org/10.46504/10201510mc

Meulenbroeks, R. (2020). Suddenly fully online: A case study of a blended university course moving online during the Covid-19 pandemic. *Heliyon*, *6*(12), e05728. https://doi.org/10.1016/j.heliyon.2020.e05728

Murillo, A. P., & Jones, K. M. L. (2020). A "just-in-time" pragmatic approach to creating quality matters-informed online courses. *Information and Learning Sciences*, *121*(5), 365-380. https://doi.org/10.1108/ILS-04-2020-0087

Nachtigall, C., Kroehne, U., Funke, F., & Steyer, R. (2003). (Why) should we use SEM? Pros and cons of structural equation modeling. *Methods of Psychological Research Online*, *8*(2), 1–22. https://doi.org/10.23668/psycharchives.12783

OECD. (2022). *The state of global education.* Retrieved from https://www.oecd.org/en/publications/2021/09/the-state-of-global-education_f3f08b36.html

OECD. (2023). *PISA 2022 results (Volume I): The state of learning and equity in education*, *PISA*. Paris: OECD Publishing. https://doi.org/10.1787/53f23881-en.

Quinn, D., & Aarão, J. (2020). Blended learning in first year engineering mathematics. *ZDM*, *52*(1), 927-941. https://doi.org/10.1007/s11858-020-01160-y

Ralston-Berg, P., Buckenmeyer, J., Barczyk, C., & Hixon, E. (2015). Students' perceptions of online course quality: How do they measure up to the research? *Journal of Online Learning Research and Practice*, *4*(1), 38-55.

Ruipérez-Valiente, J. A., Staubitz, T., Jenner, M., Halawa, S., Zhang, J., Despujol, I., & Reich, J. (2022). Large scale analytics of global and regional MOOC providers: Differences in learners' demographics, preferences, and perceptions. *Computers & Education*, *180*(1), 104426. https://doi.org/10.1016/j.compedu.2021.104426

Serrano, D. R., Dea-Ayuela, M. A., Gonzalez-Burgos, E., Serrano-Gil, A., & Lalatsa, A. (2019). Technology-enhanced learning in higher education: How to enhance student engagement through blended learning. *European Journal of Education*, *54*(2), 273–286. https://doi.org/10.1111/ejed.12330

Shachar, M., & Neumann, Y. (2010). Twenty years of research on the academic performance differences between traditional and distance learning: Summative meta-analysis and trend examination. *MERLOT Journal of Online Learning and Teaching*, *6*(2), 318.

Shonfeld, M., & Magen-Nagar, N. (2020). The impact of an online collaborative program on intrinsic motivation, satisfaction and attitudes towards technology. *Technology, Knowledge and Learning*, *25*(2), 297-313. https://doi.org/10.1007/s10758-017-9347-7

Spencer, D., & Temple, T. (2021). Examining students' online course perceptions and comparing student performance outcomes in online and face-to-face classrooms. *Online Learning*, *25*(2), 233-261. https://doi.org/10.24059/olj.v25i2.2227

Taylor, C., Roehrich, H., & Grabanski, J. (2018). External factors that impact online instructor performance: A study measuring the impact of decision fatigue & quality matters recognition of courses on online instructor evaluation. *Online Journal of Distance Learning Administration*, *21*(3), 1-13.

Tibbetts, M., Epstein-Shuman, A., Leitao, M., & Kushlev, K. (2021). A week during COVID-19: Online social interactions are associated with greater connection and more stress. *Computers in Human Behavior Reports*, *4*, 100133. https://doi.org/10.1016/j.chbr.2021.100133

UNESCO. (2020). *Education: From COVID-19 school closures to recovery.* Retrieved from https://www.unesco.org/en/covid-19/education-response

Van de Schoot, R., Lugtig, P., & Hox, J. (2012). A checklist for testing measurement invariance. *European Journal of Developmental Psychology*, *9*(4), 486-492. https://doi.org/10.1080/17405629.2012.686740

World Health Organization. (2020). *Rational use of personal protective equipment (PPE) for coronavirus disease (COVID-19): Interim guidance, No. WHO/2019-nCoV/IPC PPE_use/2020.2).* Retrieved from https://iris.who.int/bitstream/handle/10665/331498/WHO-2019-nCoV-IPCPPE_use-2020.2-eng.pdf

Wright, G., Volodarsky, S., Hecht, S., & Saxe, L. (2023). Student satisfaction and the future of online learning in higher education: Lessons from a natural experiment. *Online Learning*, *27*(1), 335-355. https://doi.org/10.24059/olj.v27i1.3224

Zeng, X., & Wang, T. (2021). College student satisfaction with online learning during COVID-19: A review and implications. *International Journal of Multidisciplinary Perspectives in Higher Education*, *6*(1), 182-195.

Zimmerman, W., Altman, B., Simunich, B., Shattuck, K., & Burch, B. (2020). Evaluating online course quality: A study on implementation of course quality standards. *Online Learning*, *24*(4), 147-163. https://doi.org/10.24059/olj.v24i4.2325

Zizka, L., & Probst, G. (2023). Learning during (or despite) COVID-19: Business students' perceptions of online learning. *Quality Assurance in Education*, *31*(1), 60-73. https://doi.org/10.1108/QAE-12-2021-0188

Appendix 1. Items of the course quality and technology satisfaction scales.

Factor	Item code	Item text
Course quality	CoursQual1	The instructor is responsive to student needs.
	CoursQual2	The quality of instruction is excellent.
	CoursQual3	There was a lot of student–instructor interaction.
	CoursQual4	I am satisfied with this course.
Technology satisfaction	TechSatis1	I had no problems accessing this course.
	TechSatis2	The technology is easy to use.
	TechSatis3	The technology is user-friendly.
	TechSatis4	I learned how to use the technology quickly.
	TechSatis5	The technology does everything that I would expect it to do.