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Technostress in students and quality of online learning: role of instructor and university support

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Online learning provides flexibility and convenience to students, however, it also presents various challenges, such as technostress. Technostress is the psychological discomfort or stress experienced by individuals due to the use of technology, particularly when they cannot cope with its demands. Students' technostress levels can have a negative impact on their online learning experiences. Drawing from the Community of Inquiry (CoI) framework, the study investigates the moderating impact of instructor and university support on technostress and the quality of online learning relationship in university students. Data were collected from 392 university students taking one or more online courses. Results reveal that technostress has a negative impact on the quality of online learning. However, this negative impact is mitigated in the presence of support from the instructor and the university separately and jointly. The study makes an important contribution to the growing body of knowledge by identifying instructor support and university support as important contributors to the communities of inquiry in an online educational setting.

KEYWORDS

technostress, online learning, instructor support, university support, community of inquiry (COI)

Introduction

Technostress is a term used to describe the negative psychological and physiological impacts that individuals may experience as a result of their use of technology, including digital devices and online platforms. Technostress can affect students' cognitive processes, including attention, memory, and learning ability. [Conrad et al. \(2022\)](#) found that information overload and perceptions of technical abilities are linked to predicting students' difficulty and satisfaction with online learning environments. Similarly, [Zia et al. \(2023\)](#) also found students unsatisfied with online/ virtual classroom learning experiences concerning clinical and practical skills. People who experience technostress have a decreased ability to process, concentrate, and retain information, negatively impacting their overall performance ([Tarafdar et al., 2015](#)).

Furthermore, technostress can lead to increased anxiety and stress levels among individuals. [Torales et al. \(2022\)](#) found that technostress is significantly associated with increased anxiety and depression among college students. This increased anxiety and stress can lead to lower academic achievement and reduced quality of learning. The negative impact of technostress on the quality of online learning (QOL) is a growing concern in higher education institutions. It can lead to reduced engagement, lower cognitive processing ability, and increased anxiety and stress levels ([Torales et al., 2022](#); [Vallone et al., 2023](#)), all of which

can negatively impact the overall quality of online learning. Thus, higher education institutions must address technostress and provide students with the necessary support and resources to manage it effectively.

There are two major contexts for learner support, including course context and institutional context (Thorpe, 2002). Course support is support coming from the instructor during the course implementation process. In contrast, institutional support/university support includes support regarding admission, registration, scholarship, research, student life issues, library services, help desk, and computer labs and facilities (Thorpe, 2002; Selim, 2007).

The two-way communication between the instructor of a course and its learners is known as learner and instructor interaction (Moore and Kearsley, 1996) and is part of course support that students may have. Adewale and Tahir (2022) found instructor support and interaction as an important predictor of student satisfaction in an online learning process. This support and interaction include guidance, support, evaluation, and encouragement (Moore, 1989). Ozfidan and El-Dakhs (2023) found learner-instructor interaction to be an important indicator of learner satisfaction in an online learning environment. Recent Literature findings support that learner-instructor interaction in the form of support from an instructor is the best predictor of course satisfaction (Thurmond, 2003; Bolliger and Martindale, 2004; Adewale and Tahir, 2022; Tharapos et al., 2023). Thurmond (2003) and Adewale and Tahir (2022) found this support as a significant predictor of student satisfaction in online learning environments. Similarly, Bolliger and Martindale (2004) and Tharapos et al. (2023) found that support in the learning environment coming from instructors is the most important factor impacting the students' quality of learning and is the only required interaction for enhancing their learning experience and course satisfaction. Students who received high levels of instructor support in the course context reported higher satisfaction and better academic performance than those who received low support.

There is a lack of research that has investigated how common technostress is among the younger generation, especially students. The presence of technostress in students can result in increased challenges for higher education institutions, such as reduced productivity, higher dropout rates, and students straying from their academic responsibilities. Consequently, it is crucial to investigate the extent of technostress among students and its associated outcomes (Upadhyaya and Vrinda., 2021). Technical problems students face during online learning environments are the major factor affecting their satisfaction (Song et al., 2004; Kamaludin and Sundarasan, 2023). According to Lee et al. (2011), The main issue arises when students must learn how to effectively utilize available support when encountering problems in online and virtual environments. This identifies the importance of the university's support role in helping and resolving technical issues and problems.

In the current study, we have looked into the factors that can help mitigate the negative impact of technostress experienced by students on their online learning experiences. We have proposed instructor support and institution support as boundary conditions that can help reduce the negative consequences of technostress on the quality of online learning. The study makes an important contribution to the existing body of knowledge in two ways. First, we have proposed a model using the Community of Inquiry (CoI) Framework (Garrison et al., 2000, 2001) where we have tested the separate and joint impact of instructor support and institution support on technostress and online learning of students. Secondly, we have tested the model using data from Pakistan, a

developing economy. This presents a very different context regarding the availability of the Internet and other ITC services. Maintaining a reliable internet connection is crucial for students' online learning experiences. The disparities in digital readiness and varying pedagogical approaches between different countries can impact how students engage with online learning (Berge, 2005). Digital readiness refers to a country's level of access to and adoption of information technologies and related infrastructure. For instance, Western countries like the United States (ranked third) exhibit significantly higher digital readiness compared to Asian nations like Pakistan (ranked 124th) (Cisco, 2023). Students from countries with lower digital readiness levels may encounter additional technology-related challenges and experience more stress. Recent studies conducted during the COVID-19 pandemic support this notion. For instance, Agung et al. (2020) found that more than two-thirds of students in rural Indonesia reported problems such as unreliable internet, insufficient data access, and incompatible learning devices.

Literature review

Community of inquiry framework

The Community of Inquiry (CoI) framework, developed by Garrison et al. (2000, 2001), emphasizes the importance of three interrelated presences in the learning environment: cognitive, social, and teaching. Each presence contributes to the learning experience. Based on CoI, these three presences are important for the online learning experience, too.

The cognitive presence refers to the extent to which learners can construct meaning through sustained communication (Garrison et al., 2000, 2001). Support from teachers/ instructors can enhance cognitive presence by providing guidance, facilitating discussions, and promoting critical thinking skills among students. Similarly, university support can enhance cognitive presence by providing faculty with training and resources to design and facilitate effective online learning experiences. This support helps instructors create opportunities for critical thinking, problem-solving, and meaningful discussions, thereby improving the quality of online learning.

Social presence is the degree to which participants in an online course perceive each other as real people and are able to establish a sense of community (Garrison et al., 2000, 2001). Support from teachers/ instructors can help in creating opportunities for students to interact, collaborate, and build relationships in the online environment. Universities can also provide resources for fostering social presence, such as discussion forums, virtual office hours, and peer collaboration activities. University support can facilitate social presence by offering tools and platforms for communication and collaboration, promoting student engagement, and providing guidelines for creating inclusive and interactive online environments. This support fosters a sense of belonging and student interaction, creating a more positive online learning experience.

Teaching presence refers to the design, facilitation, and direction of the online learning experience by the instructor or course designer (Garrison et al., 2000, 2001). Universities can support teachers by offering professional development opportunities, training in online pedagogy, and access to instructional design resources. Effective teaching presence is crucial for guiding students through learning and providing clear instructions and feedback. University support can empower instructors and students with training in online pedagogy, instructional design, and

the effective use of educational technology. When instructors and students receive adequate support, they are better equipped, thus strengthening teaching presence and enhancing the overall quality of online learning. Based on the above discussion, we propose that both instructor and university support play an important role in the online learning experience. Based on the Community of Inquiry (CoI) framework, we propose support mechanisms (instructor support and institutional support) help attenuate technostress's negative effect on the online learning quality of students.

Chimbo et al. (2023) while using COI identified the challenges encountered by South African students in distance e-learning environments. Purwandari et al. (2022) investigated the Indonesian engineering students learning experiences in an e-learning environment while using COI framework and concluded instructor support/ presence is a major contributor to the cognitive presence. Similarly, in the bibliometric analysis of COI in online contexts over 25 years Yu and Li (2022) reported that teaching, social and cognitive presence as well as metacognition and self-efficacy played an integral role in COI framework in an online learning context.

Technostress among students and quality of online learning

Although the advantages of technology in educational institutions are undeniable (Alenezi, 2021; Alenezi et al., 2023), there has been a growing focus on comprehending the adverse effects it can have on individuals who use it. The concept of technostress, defined as the "inability to effectively manage new technologies," has received significant attention in organizational research, particularly concerning its influence on employees' job-related outcomes (Tarafdar et al., 2014; Tarafdar et al., 2019; Torres et al., 2021). However, there is little attention in the literature to technostress experienced by students (Upadhyaya and Vrinda., 2021).

The COVID-19 pandemic has forced many educational institutions to shift to online learning, which has led to the rise of technostress among students. With the sudden shift to online learning, students had to adapt to new digital tools, which was a challenge for many. Not every learner is accustomed to the use of an e-learning environment for educational purposes (Alenezi et al., 2023). Upadhyaya and Vrinda (2021), while using data from 673 Indian private university students, found that students reported feeling overwhelmed by the technology used in online learning and experienced a moderate level of technostress. Additionally, they also found that technostress has a negative impact on the academic productivity of students. Furthermore, the increased screen time during online learning has led to physical and mental health issues among students. For example, the blue light emitted from screens has been linked to eye strain, headaches, and disrupted sleep patterns (Vandendriessche et al., 2019). Additionally, the isolation and lack of social interaction during online learning have led to mental health issues such as depression and anxiety (Azmi et al., 2022; Torales et al., 2022; Vallone et al., 2023).

The quality of online learning has a significant impact on student's academic performance and well-being. Awang Kader et al. (2022) found a negative correlation between technostress in students and their intentions to use online learning. Similarly, Mushtaque et al. (2022) also found a negative association between technostress and the

online learning experiences of medical students. They also found that students experienced high levels of technostress during the transition to online learning, with factors such as poor internet connectivity, lack of technical support, and difficulty in accessing course materials contributing to their stress levels.

Hypothesis 1: Technostress in students will negatively affect their quality of online learning.

Instructor support as a moderator

The important finding by Awang Kader et al. (2022) regarding the impact of teaching-related factors on technostress suggests that teachers and instructors should provide increased encouragement, support, and guidance to help students improve their familiarity with the online learning environment. This, in turn, can help in reducing technostress in students. Additionally, as technology conditions contribute to a greater occurrence of technostress incidents in learning environments, the influence of these facilitating conditions in the form of instructor support is substantial.

According to Saal et al. (2019), a teacher can facilitate social interaction and communication both with their students and among the students themselves. However, students can become disinterested in lessons involving technology, primarily due to the teacher's control over the technological tools. Such strict control by the teacher can disrupt communication between students and their instructors. Similarly, the absence of social communication between teachers and students during online interactions can lead to many students choosing not to continue their learning journey (Adnan and Anwar, 2020).

The instructor's support in real-time response, teaching style, and attitude in helping the student through online learning platforms has a significant positive impact on students' perceived ease of use and usefulness (Mo et al., 2021). Instructor support involves providing real-time feedback on student questions to narrow learning gaps and establish a more comprehensive learning process (Cidral et al., 2018; Mo et al., 2021). This is because instructors can create a series of instructional activities and learning resources, fostering effective learning through interaction, exchange, and the use of appropriate instructional tools (Rodríguez-Ardura and Meseguer-Artola, 2016; Luan et al., 2023). In the context of online learning courses, a positive attitude from instructors contributes to continuous learning and better learning outcomes. Support from the instructor can positively contribute to the student's willingness to embrace online learning.

Hypothesis 2: Instructor's support attenuates technostress's negative effect on the online learning quality of students.

University support as a moderator

Vallone et al. (2023) identify the importance of establishing an academic community and social support networks through in-person interactions and the use of information and communication technologies (ICTs). According to them, this approach will help students actively choose their academic paths while mitigating the risks associated with excessive technology use. University support can help develop academic community and social support networks.

Henrie et al. (2015), in a comprehensive review of the literature, found institutional support for e-learning as an important indicator for enhancing students' engagement in online courses. Universities can support students and faculty members by providing technical assistance to help alleviate technostress. This assistance can provide access to reliable technology, software, and technical support. Furthermore, universities can also provide training and workshops to students and educators to help them improve their technical skills and use technology effectively. The shift to online learning can be isolating, leading to feelings of loneliness and disconnection from the learning community. Universities can offer online forums, virtual office hours, and social events to help students and educators connect and build a sense of community. This can reduce anxiety and frustration associated with using technology for learning. Moreover, universities can provide emotional and social support to students and educators (Luan et al., 2023).

University support can play a crucial role in improving the quality of online learning (Iqbal et al., 2022; Azila-Gbettor et al., 2023). Generally, university support comprises the resources that aid various stakeholders, including professors and students, in effectively and efficiently fulfilling their responsibilities (Pedro and Kumar, 2020). This support can include providing resources, such as online libraries, e-books, and academic journals, to enhance students' learning experience. In the context of online learning, university support can be defined as the provision of technological infrastructure and digital resources aimed at facilitating effective online education. Research has demonstrated that the assistance universities provide, both in terms of technological infrastructure and instructional support, plays a crucial role in the successful implementation of high-quality online teaching and learning (Pedro and Kumar, 2020; Azila-Gbettor et al., 2023).

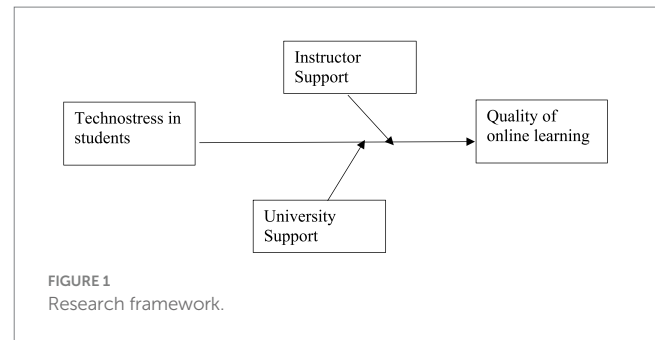
Abubakari et al. (2022) found university support as a significant predictor of international students' engagement in online learning. Similarly, Masrom (2008) found that availability of technical support or help desk as an institutional support factor is the most critical measure for success in e-learning environments. Additionally, universities can offer personalized support, such as online tutoring, mentoring, and coaching, to help students overcome challenges and achieve their academic goals. Based on the above discussion, support from the university can attenuate the negative impact of technostress on the quality of online learning.

Hypothesis 3: The University's support attenuates technostress's negative effect on the online learning quality of students.

The proposed research framework is presented in Figure 1.

Methodology

The present study examines the impact of technostress encountered by students in an online learning environment on their perception of learning quality. Instructor support and university support roles were also investigated on the proposed relationship. The positivist approach was utilized and a quantitative research design was employed to investigate the proposed model. SPSS (Statistical Package for the Social Sciences) and PROCESS macro (Hayes, 2018) was used as analytical tools.



Sample and data collection

We have used the Google survey form for data collection. The authors used their references to distribute the electronic version of the survey form to different public and private sector universities in Pakistan. Four hundred and thirty-five responses were received back, 43 responses were excluded due to incomplete information and missing values, and 392 responses were analyzed for the final analysis.

Instrumentation

A closed-ended survey form was used for the collection of responses. The technostress was measured using a 14-item scale with three underlying dimensions, including techno-overload, techno-complexity, and techno-invasion was adapted from Tarafdar et al. (2007). We have made slight modifications to the scale to measure students' technostress. It comprises 14 statements with three underlying dimensions: techno-overload, techno-complexity, and techno-invasion. The sample statements included are, for example, "I am forced by technology to work much faster," "I am forced by technology to do more work than I can handle," and "I am forced by technology to work with very tight time schedules."

For measuring the university support, five items were adopted from Saleem et al. (2022). The sample items are: "Guidance/tutorials on the access and use of learning management systems or other modes of online education." and "Availability of learning material and library resources for course completion." Similarly, to measure the instructor's support, the 10-item scale is adopted from Saleem et al. (2022). The sample items were: "Availability for consultation and guidance after class hours (WhatsApp, Messages, E-mails, etc.)" and "In-time delivery of course content."

Lastly, four items were adapted from Cobb (2009) to measure the quality of online learning. The sample items are "I was able to learn from the online discussions and online class activities." And "I was able to learn from the online course offered by my university."

Results

Demographic analysis

The demographic characteristics of the sample were analyzed using SPSS. It shows that most respondents were male (61.7%). Most respondents were from public sector universities (82%), while 56% of

respondents were enrolled for an undergraduate degree. The demographic information of the respondents is shown in [Table 1](#).

Control variables

To check the control variables, we used a one-way ANOVA test. The results indicated that gender was significantly related to the technostress ($F=5.08, p=0.00$). University type was significantly related to university support ($F=8.24, p=0.00$), instructor support ($F=4.89, p=0.00$), and technostress ($F=4.33, p=0.00$). Similarly, the degree level was significantly related to instructor support ($F=5.46, p=0.00$), and quality of online learning ($F=6.92, p=0.00$) and discipline was significantly related to instructor support ($F=3.28, p=0.00$). Hence, we have controlled all demographic variables while conducting further analysis.

Common method variance

Herman’s single-factor analysis was used to check the common method variance ([Schoofs et al., 2010](#)). Exploratory factor analysis using principal component analysis with no rotation, and all measured items were loaded into a single factor explaining about 39% variance. Below the recommended threshold value of 50% ([Podsakoff et al., 2003](#)). Hence it was concluded that there was no issue of common method variance.

Confirmatory factor analysis

The psychometric properties of the measures were examined through confirmatory factor analysis (CFA) based on the four-factor model, namely TS, QOL, US, and IS. The CFA resulted in an acceptable fit (GFI=0.86, CFI=0.96, AGFI=0.84, RMR=0.06, RMSEA=0.05, $\chi^2=1029.80, df=486, p<0.001$).

Reliability and validity

The reliability of scales used to measure latent constructs was assessed with the help of two indexes, Cronbach’s alpha and composite reliability. The results identified that the index values of both reliability measures were greater than the recommended threshold value of 0.60 ([Nunnally and Bernstein, 1994](#)). Similarly, convergent validity, average variance extracted (AVE), and discriminant validity values were used to assess the validity of the collected data. All items were successfully loaded (with regression weights greater than 0.60) into their respective factors, indicating convergent validity. Similarly, for the assessment of AVE, all variables showed AVE values greater than the proposed cut-off value of 0.5. Results of the reliability and validity analyses are presented in [Table 2](#).

Finally, [Fornell and Larcker’s \(1981\)](#) criterion was utilized to assess the discriminant validity of the collected data set. According to [Fornell and Larcker’s \(1981\)](#) criterion, the AVE of all variables should be greater than the square of the correlation of each factor. After comparing the AVE and shared variance, it was concluded that the collected data set is discriminately valid. The results of the correlation coefficient, shared variance, and AVE for assessment of discriminant validity are presented in [Table 3](#).

Hypotheses testing

The proposed model is a double moderator model where instructor support (IS) and university support (US) were presented as moderators for technostress and the quality of online learning relationship. We used Process model 2 of PROCESS macro ([Hayes, 2018](#)) to test our dual moderated model and the proposed hypotheses. We have added the controlled variables as covariates in the model. This step added the US*TS and IS*FS interactions to the regression equation predicting QOL. In summary, TS negatively and significantly impacts QOL [$\beta=-0.081, t(392)=-2.35, p=0.019, sr^2=0.39$], leading to the acceptance of H1. Similarly, both interactions US*TS [$\beta=0.111$,

TABLE 1 Demographic analysis.

Variables	Categories	Frequency	Percent
Gender	Male	242	61.7%
	Female	150	38.3%
Degree enrollment	Undergraduate (14 years)	220	56.1%
	Graduate/Masters (16 years)	134	34.2%
	Research students MS/Ph.D. (18 years)	38	9.70%
University	Public	322	82.1%
	Private	70	17.9%
Discipline	Arts and Humanities	54	13.8%
	Social Sciences	65	16.6%
	Sciences	113	28.8%
	Health Sciences	39	9.90%
	Engineering and Technology	39	9.90%
	Business/Management/Commerce	62	15.8%
	Others	20	5.10%

TABLE 2 Results of confirmatory factor analysis (CFA).

Construct/Variable	β	Alpha	CR	AVE
Technostress (TS)		0.970	0.947	0.761
TEC1	0.839			
TEC2	0.883			
TEC3	0.868			
TEC4	0.866			
TEC5	0.842			
TO1	0.870			
TO2	0.917			
TO3	0.891			
TO4	0.923			
TO5	0.911			
TI1	0.840			
TI2	0.887			
TI3	0.883			
TI4	0.844			
Instructor support (IS)		0.929	0.931	0.575
IS1	0.825			
IS2	0.774			
IS3	0.811			
IS4	0.706			
IS5	0.750			
IS6	0.647			
IS7	0.729			
IS8	0.814			
IS9	0.806			
IS10	0.700			
University support (US)		0.907	0.908	0.663
US1	0.807			
US2	0.842			
US3	0.782			
US4	0.827			
US5	0.811			
Quality of online learning (QOL)		0.855	0.863	0.615
QOL1	0.721			
QOL2	0.883			
QOL3	0.865			
QOL4	0.641			
Goodness of fit indices				
$\chi^2 = 1029.80$; d.f. = 486; $\chi^2/d.f. = 2.11$; $p < 0.001$; CFI = 0.96; GFI = 0.86; AGFI = 0.86; RMR = 0.06; RMSEA = 0.05				

β , standardized coefficient; Alpha, Cronbach's alpha; CR, composite reliability; AVE, average variance extracted.

$t(392) = 2.60, p = 0.009, sr^2 = 0.39$] and $US \times TS$ [$\beta = 0.1265, t(392) = 2.88, p = 0.004, sr^2 = 0.39$] are significant Hence H2, H3 are also accepted. Results of Process model 2 are presented in Table 4.

In addition to the hypothesized relationships, we tested the conditional effects of TS in the presence of two moderators. Table 5

shows the magnitude of the effect of TS on QOL in the presence of different values of IS and US. The results of the moderated analysis show that the conditional effect of TS at lower values of the US and low and neutral values of IS is significant and negative and turns insignificant when the IS becomes high. While for the high values of

TABLE 3 Descriptive statistics and correlations.

	Variable	No of items	Mean	s.d.	TS	IS	US	QOL
1	TS	14	3.22	1.13	0.761			
2	IS	10	2.43	0.89	-0.249* (0.062)	0.575		
3	US	5	2.13	0.93	0.203* (0.041)	0.659* (0.434)	0.663	
4	QOL	4	2.98	0.95	-0.235* (0.055)	0.555* (0.308)	0.528* (0.279)	0.615

*Correlation significant at 0.01. Shared Variance are in parenthesis AVE is on diagonal.

TABLE 4 Five thousand bootstrap results for PROCESS Model 2.

Path	Estimate	SE	LL 95% CI	UL 95% CI
TS → QOL	-0.082**	0.03	-0.151	-0.035
US → QOL	0.292*	0.05	0.183	0.403
IS → QOL	0.371*	0.06	0.488	0.253
TS-X-IS → QOL	0.126*	0.08	0.040	0.213
TS-X-US → QOL	0.111*	0.04	0.027	0.195
Gender	-0.010	0.08	-0.017	0.151
Type	0.005	0.10	-0.199	0.209
Degree	0.114	0.06	-0.002	0.231
Field	0.028	0.02	-0.015	0.171
Standardized Effects using 5,000 Bootstrap 95% CI				
Effect	R2-change	F-value	p-value	
QOL*US	0.017**	6.77	0.009	
QOL*IS	0.013*	8.33	0.004	
Both	0.015	4.61	0.011	
Model fit				
F-value	27.679*			
R ²	0.395			
R	0.628			

*p<0.01; **p<0.05, ***p<0.10.

TABLE 5 Five thousand bootstrap results for conditional effects PROCESS Model 4.

Conditional effects using 5,000 bootstrap 95% CI					
Effect at different values of US	Effect at different values of IS	Effect	SE	LL 95% CI	UL 95% CI
-0.9262	-0.8892	-0.298*	0.08	-0.456	-0.140
-0.9262	0.000	-0.185*	0.05	-0.289	-0.082
-0.9262	0.8892	-0.073	0.04	-0.164	0.019
0.0000	-0.8892	-0.195*	0.05	-0.300	-0.089
0.0000	0.000	-0.082**	0.03	-0.151	-0.013
0.0000	0.8892	0.030	0.05	-0.070	0.131
0.9262	-0.8892	-0.092***	0.05	-0.188	0.005
0.9262	0.000	0.021	0.05	-0.834	0.125
0.9262	0.8892	0.133***	0.08	-0.022	0.288

*P<0.01; **P<0.05, ***P<0.10.

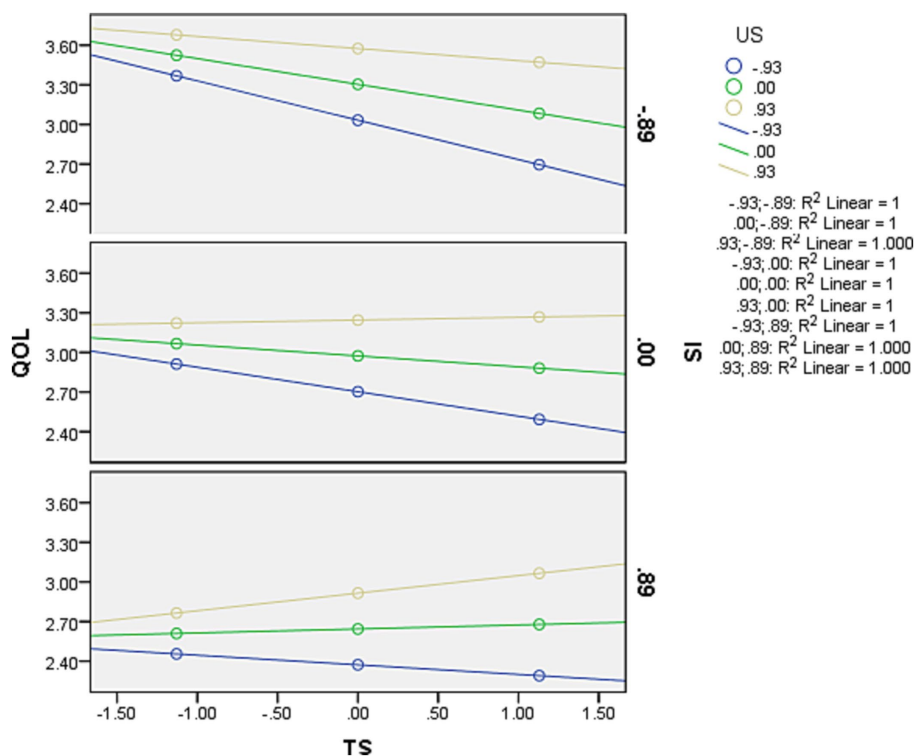


FIGURE 2 Interaction plot.

US and lower value of IS, the effect is less but still significantly negative and becomes significantly positive at high values of US and IS. The interaction plot explains the effects of TS on QOL in the presence of high, moderate, and low values of US and IS are presented in Figure 2.

Discussion and conclusion

The study examined the effect of technostress experienced by students on their quality of online learning with two moderators, the university support and the instructor support. The first hypothesis was examined and found that students' technostress had a negative effect on the quality of online learning (Hypothesis 1). It resulted in the acceptance of hypothesis 1. The impact of technostress on students' academic performance, well-being, and satisfaction has been widely studied in the literature (Brod, 1984; Ragu-Nathan et al., 2008). The results follow the existing literature examining similar links (Upadhyaya and Vrinda, 2021; Awang Kader et al., 2022; Mushtaque et al., 2022). Studies have shown that technostress has a negative impact on the quality of online learning. One of the main reasons for technostress's negative effect on online learning quality is that it can lead to reduced student engagement and motivation. Upadhyaya and Vrinda (2021) argued that students who experience technostress are less likely to participate in online discussions, interact with their peers and instructors, and complete their assignments on time. This lack of engagement can lead to a decline in academic performance and a lower quality of learning.

In recent years, online learning has become increasingly popular as a flexible and convenient alternative to traditional classroom instruction. However, online learning can also lead to technostress. Technostress negatively impacts the quality of online learning, making it crucial to

identify factors that can help mitigate its negative effects. One such factor is instructor support. We found support for the second hypothesis. The instructor's support significantly moderates the relationship between students' technostress and the quality of online learning. Instructor support acts as a boundary condition that helps mitigate the negative impact of technostress on the quality of online learning in students.

Research has shown that instructor support significantly moderates the relationship between students' technostress and the quality of online learning. Cavanaugh et al. (2004) and Adewale and Tahir (2022) found that instructor support positively correlated with student satisfaction and performance in online courses. Specifically, students who reported receiving high levels of instructor support reported higher levels of satisfaction and better academic performance than those who received low levels of support. Similarly, Cho and Berge (2002) argued that instructor support was the most significant predictor of student satisfaction in online courses. Instructor support helps to mitigate technostress in several ways. First, instructors can provide clear and concise instructions for using new technologies, which can reduce confusion and anxiety for students (Saal et al., 2019; Adnan and Anwar, 2020). Additionally, instructors can offer ongoing support and feedback throughout the course, which can help students feel more confident and less anxious about their progress (Cavanaugh et al., 2004). Finally, instructors can create a positive and supportive learning environment, which can help to reduce stress and anxiety overall (Cho and Berge, 2002).

It is important to note that instructor support can come in many forms, including email communication, discussion boards, virtual office hours, and personalized assignment feedback. Therefore, instructors should strive to provide multiple avenues for support to meet the diverse needs of their students. Instructor support significantly moderates the relationship between students' technostress and the quality of online

learning because providing clear instructions, ongoing support, and a positive learning environment can help to mitigate technostress and improve student satisfaction and performance in online courses. Instructors should prioritize providing support in various forms to meet the diverse needs of their students, which can ultimately lead to a more positive and successful online learning experience.

The data also supports the third hypothesis examining the university support as a boundary condition for students' technostress and the quality of online learning relationship. The university support significantly moderates the relationship between technostress and the quality of online learning. By providing students with resources, assistance, and a sense of community, universities can help alleviate technostress and promote a positive online learning experience. Universities increasingly rely on online learning to facilitate their educational programs as the world becomes more digitized. However, this shift to online learning has also led to increased technostress among students, which is the stress and frustration experienced due to using technology (Tarafdar et al., 2019).

University support refers to the resources and assistance provided to students by their university, such as technical support, academic advising, and counseling services (Pedro and Kumar, 2020; Azila-Gbette et al., 2023). The more support students receive from their university, the less likely they are to experience a decrease in the quality of their online learning due to technostress (Iqbal et al., 2022). One possible explanation for this finding is that university support can help alleviate technostress by providing students with the resources and assistance they need to effectively use technology in their online learning. For example, technical support can help students troubleshoot issues with their devices or software, while academic advising can help students navigate online course materials and develop effective study strategies (Masrom, 2008; Henrie et al., 2015). Additionally, counseling services can provide students with mental health support, which can help reduce the negative effects of technostress on their learning experience. Another possible explanation is that university support can help create a sense of community and connection among students, which can mitigate the isolation and disconnection that may exacerbate technostress. For example, universities may offer virtual peer support groups or online social events to help students connect with their peers and feel a sense of belonging in the online learning environment (Vallone et al., 2023).

Further, it is found that the conditional effect of students' technostress at lower values of the university support and low and neutral values of instructor support is significant and negative and turns insignificant when the instructor support becomes high. While for the high values of university support and lower value of instructor support, the effect is less but still significantly negative and becomes significantly positive at high values of university support and instructor support. This is because technostress creates negative psychological and physiological reactions that occur when individuals feel unable to cope with technology in a healthy manner (Tarafdar et al., 2019).

Moreover, when the level of instructor support is low or neutral, the negative effect of technostress on academic performance is also significant. However, the negative effect of technostress on academic performance becomes insignificant when the level of instructor support is high. On the other hand, when students perceive high levels of university support and lower levels of instructor support, the effect of technostress on academic performance is still significantly negative, but the effect size is smaller. Interestingly, when both university and instructor support is high, the effect of technostress on academic performance becomes significantly positive. These findings suggest

that university and instructor support can buffer the negative effect of technostress on students' academic performance and may even turn it into a positive effect when support is high.

This research concludes that technostress has emerged as a significant challenge for students engaged in online learning. The negative impact of technostress on the quality of online learning has been well documented, and it has been observed that students who experience higher levels of technostress are likely to have lower academic performance and higher dropout rates. This issue has become more critical since the COVID-19 pandemic, which has forced many educational institutions to shift to online learning, often with limited resources and training.

However, the role of instructor and university support in moderating the relationship between students' technostress and the quality of online learning must be considered. It has been found that students who receive adequate support from their instructors and universities are better equipped to manage technostress and achieve better learning outcomes. Instructors who provide clear communication, timely feedback, and appropriate resources can help students cope with technostress. At the same time, universities that invest in effective technical infrastructure and support systems can improve students' online learning experience. The negative impact of technostress on online learning is undeniable, but effective instructor and university support can mitigate it. Institutions must prioritize providing adequate resources, training, and support to students and instructors to ensure a high-quality online learning experience that meets the needs of all learners, regardless of their technological abilities. Ultimately, it is critical to address the issue of technostress to ensure equitable access to education for all students, regardless of their learning modality.

Theoretical and practical implications

The theoretical implications from the current investigation with reference to COI is that to develop effective communities of inquiry, the online instruction and student engagement is an important contributor. Our investigation supports that teaching presence and student's perception of learning and satisfaction from a course are connected. The cognitive presence can also be enhanced with instructor support where they can provide guidance, facilitate discussion and can help promoting critical thinking skills among students. Similarly, the university support can help in developing social presence by providing resources for fostering social presence, such as discussion forums, virtual office hours, and peer collaboration activities. University support can facilitate social presence by offering tools and platforms for communication and collaboration, promoting student engagement, and providing guidelines for creating inclusive and interactive online environments. This support fosters a sense of belonging and student interaction, creating a more positive online learning experience.

This research highlights the importance of providing adequate support to students to mitigate the negative impact of technostress on their academic performance. Universities and instructors should consider implementing interventions to enhance support for students, particularly those vulnerable to technostress. Such interventions may include training programs for instructors to develop technology skills, provide effective feedback, and offer counseling services to help students cope with technostress.

The implications of technostress on students' online learning quality are significant. Technostress is a psychological response to the use of technology that can lead to anxiety, frustration, and even

physical symptoms such as headaches or fatigue. When students experience technostress, their ability to learn effectively online is compromised. They may struggle to concentrate, complete assignments on time, or participate in online discussions. This can result in lower grades and decreased engagement with the course material. To mitigate the negative effects of technostress, educators can provide support, training, and resources to help students manage their technology use and build resilience to stress.

Moreover, the urge to shift to online teaching during and after the COVID-19 pandemic has increased students' technostress. Technostress is the anxiety or frustration experienced by individuals due to their use of technology. This can negatively impact the quality of online learning and students' academic performance. Therefore, it is crucial for universities to support moderates between students' technostress and the quality of online learning. One implication for universities is to provide adequate technical support to students, such as troubleshooting guides, tutorials, and one-on-one technical assistance. This can help students feel more confident and less anxious when using online learning tools.

Additionally, universities can offer training sessions or workshops to teach students how to use online tools and platforms effectively. Another implication is to create a positive and supportive online learning environment. This can be achieved by establishing clear expectations and guidelines for online participation, creating student interaction and collaboration opportunities, and providing regular feedback and communication. The universities must prioritize their students' well-being and academic success during this transition to online learning. By supporting moderates between technostress and the quality of online learning, universities can help students overcome the challenges of online education and achieve their academic goals.

As online learning continues to become more prevalent, it is increasingly important for instructors to be aware of the potential impact of technostress on their students. Technostress is the negative psychological and physiological reactions that occur when individuals are faced with new or unfamiliar technologies. Students who experience technostress may feel overwhelmed, anxious, or frustrated when using online learning tools, which can ultimately impact the quality of their learning. Instructors can play a critical role in mitigating the negative effects of technostress by providing effective support and guidance to their students. The current investigation supports the importance of teaching presence which is interconnected to the cognitive presence and social presence. Offering clear instructions and tutorials on how to use online tools, providing regular feedback and encouragement, and creating a supportive and collaborative online learning environment can help in enhancing the online learning experiences of students. By doing so, instructors can help reduce students' anxiety and frustration while promoting greater engagement and participation in online learning. The quality of online learning is directly impacted by the level of technostress experienced by students. Instructors who prioritize providing effective support and guidance can help mitigate the negative effects of technostress, ultimately promoting greater student success and satisfaction in online learning environments.

Limitations and future directions

The study investigated the relationship between students' technostress, the quality of online learning, and the moderating role of university support and instructor support. The research used a cross-sectional design and a closed-ended questionnaire to gather data

from 392 students. While the study provides important insights into the relationship between students' technostress, the quality of online learning, and the moderating role of university support and instructor support, it has some limitations. One limitation of the study is that it used a cross-sectional design. A longitudinal design would be ideal to establish causality and provide a more accurate understanding of the relationship between the variables.

Another limitation of the study is the use of a closed-ended questionnaire, which limits the scope of responses and the possibility of gathering detailed information from the participants. Using an open-ended questionnaire or conducting follow-up interviews could have provided a more comprehensive understanding of the participants' experiences. The study also focused on university and instructor support as moderators. Other factors, such as student motivation, learning style, and technology proficiency, may also play a significant role in students' technostress and quality of online learning. Therefore, future studies could explore the impact of these variables on students' online learning experiences. Similarly, as current investigation has utilized COI theoretical framework, future researches can use Technology Acceptance Model (TAM), Unified Theory of Acceptance and Use of Technology (UTAUT) or RAT Model (Replacement, Amplification, Transformation) as theoretical foundation. TAM focuses on how users come to accept and use technology. It can be applied to understand learners' acceptance and use of online learning tools and platforms. UTAUT is an extension of TAM and incorporates additional factors such as performance expectancy, effort expectancy, social influence, and facilitating conditions. It's widely used to predict and explain technology adoption. Similarly, RAT Model (Replacement, Amplification, Transformation) developed by [Hughes et al. \(2006\)](#), helps educators think about how technology can be integrated into teaching and learning.

Finally, the study only included responses from institutions from one country, limiting the generalizability of the findings to other institutions or student populations. Future studies could replicate the research in different contexts to determine how the findings apply to other student populations.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the participants was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Author contributions

FS: Conceptualization, Formal analysis, Investigation, Methodology, Software, Writing – original draft, Writing – review & editing. EC: Writing – review & editing, Funding acquisition,

Resources, Supervision. MM: Writing – review & editing, Data curation, Methodology, Software, Validation.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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