



## Mediating Role of Technostress and Exhaustion in the Relationship Between Digital Overload and Student Engagement

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### ABSTRACT

*The present study examined the impact of digital overload on student engagement in correlation to the mediating role of technostress and exhaustion among Pakistani Universities' students. The S-O-R model was used; the study is a quantitative cross-sectional design, where 300 undergraduate students enrolled into public sector universities of Malakand Division (Pakistan) were taken for data collection. Scales on digital overload (Lee et al., 2016; Loh et al., 2022), technostress (Cao et al., 2018; Lin et al., 2021), exhaustion (Cao et al., 2018; Yue et al., 2019), and student engagement (Fredricks et al., 2016) were used. Results showed that digital overload was significantly correlated to technostress ( $r = .41, p < .01$ ) and exhaustion ( $r = .37, p < .01$ ). Digital overload was found to be weakly but significantly positively correlated to student engagement ( $r = .25, p < .01$ ). In addition, exhaustion showed a significant mediating role ( $B = .34, p < .001$ ) in the association between digital overload and student engagement, while technostress was not a significant mediator. Although it had both facilitative and inhibitive psychological effects, digital overload only had a direct positive impact on student engagement; in other words, students were still able to "do" academic work after having engaged in substantial amounts of digital activities, but tired more easily. Findings suggest that universities need to foster digital wellness and provide interventions towards exhaustion to prevent students from disengagement and poor academic performance in reference to SDG no 3 and 4 (Good Health & Wellbeing, Quality Education)*

**Keywords:** S-O-R Framework; University Students; Digital Overload; Technostress; Exhaustion, Student Engagement.

### Introduction

The evolution of digital technology has had a profound impact on higher education, changing how students are learning to engage with academic material. [18] New digital platforms, such as learning management systems (LMS), social media, instant messaging apps, and streaming services, are becoming part of students' everyday academic and social lives. The widespread use of these technologies facilitate information access and flexible learning, while overuse or prolonged application has also brought in unexpected psychological disturbances. Digital overload is one of the most widespread issues and refers to a situation where there is an excess amount, frequency, or interactive nature of digital information, surpassing the human ability to effectively process it (Eppler & Mengis, 2004; Okeke et al.). University students are at

high risk of suffering digital fatigue, considering that they multitask constantly, receive persistent notifications, and have a need to be connected at all times across different social media networks (Alt, 2015; Lorenz-Spreen et al., 2020). Existing studies have shown that digital material overexposure may lead to attention dysfunction, low motivation, and poor academic performance (Maier et al., 2019; Tarafdar et al., 2020). By acknowledging that digital technology is omnipresent in higher education, it is important to study how digital overload can influence students' academic life and not just its immediate effects. One of the most important psychological outcomes of being overwhelmed with digital technology is technostress, which refers to "individuals' stress arising from the inability or not knowing how to cope with the use of new technologies" (Ayyagari et al., 2011; Ragu-Nathan et al., 2008). Within an academic context, employees can experience technostress due to information overload, perpetual connection, frequent changes in technology, and demands of prompt response (Tarafdar et al., 2010; Upadhyaya & Vrinda, 2021). For students, technostress has been linked to lower learning effectiveness, increased anxiety and academic dissatisfaction (Cao et al., 2018; Loh et al., 2022). Exhaustion is a form of emotional, cognitive, and physical tiredness (also referred to as burnout) brought on through long-term intensive involvement in technology (Yu et al.). Digital fatigue occurs through symptoms including lack of focus, decrease in motivation, and emotional disengagement with academic work (O'Malley et al., 2008; Malik et al., 2020; Reinecke et al., 2017). Chronic fatigue may reduce learning in students as a result of their inability to continue attending and engaging.

In higher education, student engagement is broadly recognized as an important measure of the quality of learning and academic success. It is a complex quality that incorporates behavioral, emotional, and cognitive participation in educational endeavors (Fredricks et al., 2004; Kuh, 2009). Greater engagement has been related to positive learning outcomes, persistence, and well-being, while disengagement is associated with negative performance and withdrawal (Appleton et al., 2008; Wang & Degol, 2016). Thus, it is of major concern in education to know what leads to protect or diminish engagement.

Based on the S-O-R (Stimulus–Organism–Response) model (Mehrabian & Russell, 1974), this study posits that digital overload represents an environmental stimulus that leads to internal psychological responses—technostress and exhaustion—that in turn affect behavioral outcomes, including student engagement. According to this framework, behavior is influenced by the environment only through its impact on cognitive and emotional states, providing a strong theoretical perspective for understanding the psychological mechanisms that mediate digital overload and engagement (Lin et al., 2021; Loh et al., 2022).

Thus, the present study explores the mediating role of technostress and exhaustion in the relationship between digital overload and student engagement. Through this, the study addresses a gap in the literature concerning digital well-being and student engagement and offers useful implications for educators and policymakers aiming to reduce the negative consequences of increased exposure to digital media use as well as promote sustainable engagements within increasingly digitally saturated learning contexts.

## **Methodology**

### **Research Design**

This research employed a quantitative, cross-sectional study to investigate the associations between digital overload, technostress, exhaustion, and student engagement.

### Sample and Data Collection

Data were gathered from university students of leading public sector universities of Malakand Division in Pakistan. To minimize common method bias, a two-wave data collection procedure was used. A pilot study of 100 students was conducted in the initial stage to test the reliability and clarity of measurement instruments in a local context. Step two: a sample of 300 college students was used to examine the hypotheses. It was voluntary for respondents, and informed consent was signed initially, and they could answer anonymously. strongly disagree (1) to strongly agree (5).

### Data Analysis

Processed data were analyzed using IBM SPSS (Version 27). Summary statistics consisting of descriptive measures of both demographic and study variables, were utilized. Internal consistency was assessed through a reliability calculation (Cronbach's alpha). Pearson's correlations were performed to examine relationships between digital overload, technostress, fatigue, and student engagement. A mediational model was tested to assess the indirect effect of technostress and burnout. All analyses were conducted with  $p < .05$ .

## RESULTS

To achieve the underlying objectives of the study, statistical analysis was conducted on the collected data. Descriptive statistics for all the study scales were computed to examine the normality of the data and to check the overall trends. Cronbach's alpha reliability was estimated to evaluate the internal consistency of the scales. Correlations among the scales were computed through Pearson Correlation. Moreover, for hypothesis testing, mediation analyses were carried out. The independent sample t-test analysis was done to check the gender differences among male and female students.

### 4.1 Descriptive Statistics

**Table 2:** Descriptive Statistics of four variables: Digital Overload, Technostress, Exhaustion, and Student Engagement (N=300)

Variables	$\alpha(K)$	M	SD	Skew	Kurt	Min	Max
Digital Overload	.65(4)	14.94	2.66	-.78	1.04	4.00	20.00
Technostress	.68(4)	14.48	3.05	-.32	-.41	6.00	20.00
Exhaustion	.64(3)	10.89	2.50	-.71	.09	3.00	15.00
Student Engagement	.76(7)	26.92	4.48	-1.04	1.45	10.00	35.00

*Note.* K= no of items;  $\alpha$  = Reliability; M = Mean; SD = Standard Deviation; Skew = Skewness; Kurt = Kurtosis; Min = Minimum; Max = Maximum

The displayed descriptive statistics for four variables: Digital Overload, Technostress, Exhaustion, and Student Engagement, based on a sample of 300 respondents. For each variable, 300 valid responses were collected. For each variable, it records the mean, maximum, minimum, standard deviation, skewness, and kurtosis. Descriptive statistic of the current study revealed that the Student Engagement displayed the highest value (26.92), with maximum value (35.00%) and minimum value (10.00%), and standard deviation (4.47%) while minimum Exhaustion (10.89%), with maximum mean value (15.0%), minimum (3.0%) and standard deviation (2.5%) shown in table 2.

The participant has an average level of digital overload (M = 14.95, SD = 2.66). Technostress has a moderate mean (M = 14.48, SD = 3.05), partly explaining stress based on the use of digital platforms. The lowest mean score was on Exhaustion (M = 10.89, SD = 2.50),

suggesting the participants experienced fatigue at a moderately lower level. In contrast, Student Engagement, having the highest M (M = 26.92, SD = 4.48), points to high levels of engagement in general among students.

Digital Overload kurtosis 1.04 showed that the peak is sharper than normal, Technostress -.41 later than normal, Exhaustion .09 close to normal, and Student Engagement 1.45 revealed highly peaked scores cluster near the mean. Interpretation of the study revealed that the sample size (300) is strong and constant across the variable. All scales reveal moderately high average scores. Student Engagement has the highest variation and the highest negative skew. Kurtosis values suggest some variables are more peaked.

**4.2 Pearson correlation coefficients**

S.no		1	2	3	4
1	Digital Overload	–			
2	Technostress	.41**	–		
3	Exhaustion	.37**	.52**	–	
4	Students Engagement	.25**	.21**	.28**	–

**Table 3:** Pearson correlation coefficient of four demographic variables

**Note:** \*\*. Correlation is significant at the 0.01 level (2-tailed).

The study revealed that all variables, Digital Overload, Technostress, Exhaustion, and Student Engagement, are positively correlated with each other. The strongest relationship was present between Technostress and Exhaustion ( $r = .52, p < .01$ ), while the weakest correlation involved Student Engagement, suggested to have a small but significant correlation with the other variable. The correlation between Digital Overload and Technostress ( $r = .41, p < .01$ ) and Digital Overload and Exhaustion ( $r = .37, p < .01$ ), which indicates moderate correlation, while between Digital Overload and Student Engagement ( $r = .25, p < .01$ ), which indicates weak but significant positive correlation. Similarly, the weak correlation was observed between Technostress and Student Engagement ( $r = .21, p < .01$ ) and a weak to moderate positive correlation ( $r = .28, p < .01$ ) between Exhaustion and Student Engagement, as shown in Table 3.

**4.3 Mediation analysis for the variables**

**Table 4:** Mediation Analysis for Mediation of Technostress and Exhaustion between Digital Overload and Student Engagement (N=300)

Variables	Technostress(M1)		Exhaustion (M2)		Student Engagement (Y)		95% CI	
	Model 1		Model 2		Model 3		LL	UL
	B	SE	B	SE	B	SE		
Constant	7.41	0.92	5.68	0.77	18.13	1.59	15.00	21.26
Digital Overload	0.47**	0.06	0.35**	0.05	0.26*	0.10	0.06	0.47
Technostress	-	-	-	-	0.07	0.10	-0.12	0.26
Exhaustion	-	-	-	-	0.36**	0.12	0.13	0.58
R <sup>2</sup>	0.17		0.14		0.11			
F	61.45**		47.49**		11.58**			

**Note:** B = unstandardized regression coefficient; SE = standard error; CI = confidence interval

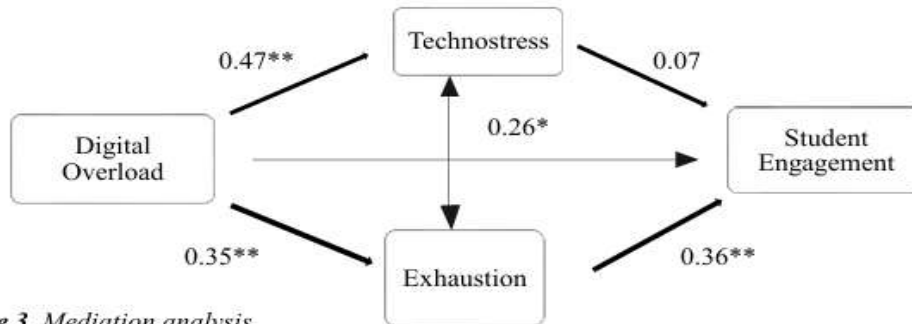


Figure 3. Mediation analysis

The present results reveal that digital overload has a strongly significant positive influence on both technostress and exhaustion, meaning that as Digital Overload rises, students have a tendency to report sophisticated levels of Technostress and Exhaustion. This reveals that Digital Overload plays a significant role in determining these two psychological dimensions. Similarly, when all three predictors (Digital Overload, Technostress & Exhaustion) were entered together to predict Student Engagement, the overall model remained significant, although only Digital Overload and Exhaustion displayed expressive effects. Digital Overload also continued to significantly predict Student Engagement after including Technostress and Exhaustion in the model, which respectively demonstrated that Digital Overload has its own direct effects on enhancing Student Engagement. Likewise, Exhaustion significantly predicted Student Engagement and thus mediates the indirect effect of Digital Overload on Student Engagement, as shown in the table. Technostress was excluded from significantly predicting Student Engagement, which refuted its mediation on the relationship with Digital Overload and Student Engagement, respectively. From a final summary perspective, Digital Overload directly and indirectly enhances Student Engagement at the same time (but in the latter case only via Exhaustion), while Technostress exerts no influence along that path. This trend emphasizes how, when it comes to the influence of Digital Overload on Student Engagement, Exhaustion stands out as a concept with distinctive relevance.

The regression analysis indicates that Digital Overload has a statistically significant positive effect on work-related: Technostress (M1) and Exhaustion (M2), as per the table. In the case of Technostress, approximately 17% ( $R^2 = 0.001$ ), and Digital Overload emerging as a clear, significant effect ( $B = 0.47$ ,  $p < .001$ ). This shows that levels of Digital Overload are related to higher levels of Techno Stress (See Table 4). The intercept of the constant (7.41) indicates the baseline level of Technostress when Digital Overload is zero. In the case of Exhaustion, the model explains 13.8% of variance ( $R^2 = .13$ ,  $p < .001$ ), and Digital Overload is once again a strong predictor ( $B = 0.001$ ), which implies that higher Digital Overload may result in greater exhaustion. Both models fit well at the overall level, obtaining statistically significant F-ratios (Technostress: 61.45; Exhaustion: 47.49); thus, concluding that Digital Overload can predict the mediating variables properly. The final regression model (MY) predicting Engagement, as can be seen from Table :11: zero fourteen, shows that the overall model is significant in predicting

Engagement indicating 10.5 % of variance in self-efficacy being explained by the included IV's ( $R^2 = .11$ ). The constant value implies that the baseline score for Student Engagement is 18.13, when all predictors are zero. In terms of predicting, Digital Overload has a minimal but significant positive effect ( $B = 0.012$ ), indicating that when Digital Overload increases, self-efficacy also increases. Exhaustion also predicts Student Engagement significantly ( $B = 0.002$ ,  $p = .002$ ), that increases in Exhaustion are associated with significant increases in self-efficacy. On the other hand, Technostress does not predict significant self-efficacy ( $B = 0.07$ ,  $p = .48$ ), thus meaning that although after the adjustment for Digital Overload and Exhaustion, Technostress does not characteristically affect Student Engagement. Full results. The overall results of the regression analysis show that Digital Overload and Exhaustion predict significantly the self-efficacy of students, while Technostress does not have an independent weight in the models.

4.5 Total, Direct, and Indirect Effects Summarized

Results indicate that Digital Overload has a positive effect on Student Engagement, both directly and indirectly. The overall impact of Digital Overload on Student Engagement is strong and statistically significant. As Digital Overload increases, there is a general tendency for an increase in Student Engagement. The direct effect still exists even after adding the mediators (Technostress and Exhaustion). This implies that Digital Overload's impact on Student Engagement is not only a mediate effect. For the indirect effects, the results indicate a significant mediation in general, in other words, Technostress and Exhaustion contribute to some extend transmission of Digital Overload on Student Engagement. When analyzed separately, Exhaustion is a significant mediator, reflecting that Digital Overload increases Student Engagement in part through an increase in exhaustion. By contrast, Technostress does not mediate the relationship. The comparison of Technostress and Exhaustion is likewise not significant, suggesting that there is no meaningful difference between the two indirect paths, with only Exhaustion emerging as the more robust mediator. Globally, the results underscore that Digital Overload affects direct and indirect Student Engagement, where Exhaustion has been playing a partial mediating role.

4.4 Gender-related differences: Independent sample t-test

**Table 5:** Independent Samples t-test for Gender showing digital overload, technostress, exhaustion, and student engagement.

Variable	Men (n = 148)		Women (n = 152)		t(298)	P	95%CI		Cohen's d
	M	SD	M	SD			LL	UL	
Digital Overload	3.62	.78	3.85	.50	-3.07	.002	-.38	-.08	.35
Technostress	3.52	.80	3.72	.71	-2.19	.029	-.36	-.02	.25
Exhaustion	3.55	.93	3.71	.72	-1.72	.086	-.35	.02	.20
Student Engagement	3.70	.72	3.99	.51	-4.07	<.001	-.43	-.15	.46

**Note:** M = Mean, SD = standard deviation t= t value, p = deeper significance LL = Lower limit UL= Upper Limit CI= Confidence Interval

In the Digital Overload, a statistically significant difference was found in the digital overload survey ( $t = -3.07$ ,  $p = .002$ ). As for the score ( $M = 3.85$ ,  $SD = 0.50$ ), the Female Student reported a significantly higher level of Digital Overload than the Male Student ( $M = 3.62$ ,  $SD = 0.78$ ). The gender difference was significant in the technostress ( $t = -2.19$ ,  $p = 0.029$ ). Females have greater technostress than males. Female students ( $M = 3.72$ ,  $SD = 0.71$ ), male students ( $M = 3.52$ ,  $SD = 0.80$ ). After running the Exhaustion, no statistically significant ( $t = -1.72$ ,  $p = 0.086$ )

differences between male and female students emerged. Male students ( $M = 3.55$ ,  $SD = 0.93$ ) and female students ( $M = 3.71$ ,  $SD = 0.72$ ). In student engagement there is a similarly large and highly significant gender difference in the result ( $t = -4.07$ ,  $p < 0.001$ ). The patterns of work can be observed to have higher engagement levels with the Female students than the male students. (Girls:  $M = 3.99$ ,  $SD = 0.51$ ), (Boys:  $M = 3.70$ ,  $SD = 0.72$ ).

### Discussion

This study investigates the association between digital overload, technostress, exhaustion, and student engagement. Which is based on the S-O-R framework. There was a clear pattern of significant patterns related to the psychological and academic responses of students after digital exposure.

Descriptive statistics showed that students perceived high levels of digital overload, technostress, and student engagement, whereas exhaustion level was relatively lower. Higher standard deviation and strong negative skewness for student engagement imply large individual differences, with many students rating themselves at an above-average level. Previous studies have revealed a positive correlation between student engagement and confidence during academic challenges (McKay et al., 2020; Schunk, 2023). The mean score of exhaustion was the lowest and still left truncation, suggesting that at least some students had quite a high level of exhaustion. Digital Overload and Technostress had a moderate spread and negative skewness, indicating that most students considered themselves to be active digitally and their stress was of somewhat greater magnitude while they were still able to function. Kurtosis-wise, Digital Overload and Student Engagement were mildly peaked (Digital Overload = 1.04, Student Engagement = 1.45), and Technostress was flatter (-0.40) (higher scatter). The evidence indicates a digitally steeped, somewhat stressed and highly engaged student body in which variance arises predominantly on engagement and technostress the same result was reported in Nastjuk et al., (2024).

Pearson's correlation analysis demonstrated significant positive correlations between the variables. The most robust relationship was found between technostress and exhaustion ( $r = .51$ ), indicating that higher technology dissatisfaction is related to more fatigue. The second group of correlations that possessed low correlation were related to the variable Digital Overload, which correlated moderately with Technostress ( $r = .41$ ) and Exhaustion ( $r = .37$ ), validating its status as an environmental stimulus in the S-O-R model. Conversely, Student Engagement relationships were milder (ranging from .215 to .282), indicating that involvement is relatively autonomous, determined not only by stress or overload but also by motivational and environmental factors.

H1: Digital overload is positively correlated to technostress and exhaustion and negatively correlated to student engagement. Hypothesis 1 was supported partially. Digital overload was positively associated with technostress and also exhaustion, confirming the expected psychological burden. But, against the hypothesis, digital overload was positively correlated with student engagement. (Notes: specific Malakand Region) In this region, the students employ online tools for learning purposes like attending their lectures, doing their assignments, and communicating rather than using the internet extensively for recreational ventures. In a digital overload scenario, it may also even intensify engagement if students are dependent upon these for success in learning. This is a two-edged sword: while overconsumption of digital technologies causes stress and tiredness, it also allows academic engagement. Thus, we partially do not support Hypothesis 1; we cannot confirm a negative association with engagement, as noted by Menguc et al. (2013).

In the mediation analysis, exhaustion mediated the correlation between digital overload and Student Engagement (lower coefficient = 0.063), and Technostress did not. Exhaustion is a broader psychological concept and includes motivation, engagement. It appears that technostress is not a direct determinant of engagement, but rather a proximal/facilitative response. Digital Overload exerted a significant direct impact on student engagement after Exhaustion was included, demonstrating partial mediation. This is in line with previous studies that suggested the double-sided effects of digital overload: stress-exhausting but also academically engaging when digital devices are a must, same result was reported by Li, X., & Liu, D. (2022).

It was also found through gender comparison analysis that female students had significantly higher digital overload, technostress, and student engagement than male students. But there was no significant difference in exhaustion by gender. Despite small effect sizes, these differences were statistically significant but of negligible magnitude, suggesting that gender-specific biases were not large. These results indicate there to be no significant difference as to how the male students are subjected by digital overload and its psychological implications compared to their female counterparts. This could be a result of approximately equal exposure to digital tools for academic as well as social interactions, especially in post-pandemic educational settings. Recent research has also provided evidence for a weakening of gender gaps in digital technology use and its stress implications amongst students at universities.

### Conclusion

Digital overload significantly increases technostress and exhaustion among university students, yet it also directly enhances student engagement due to the essential role of digital tools in contemporary learning. These findings highlight the need for universities to balance digital integration with targeted wellness strategies to reduce exhaustion while sustaining academic engagement

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