Digitally Drained: Reviving Gen Z Student Engagement in the Face of Technostress

Dr. Parul Sharma[1], Dr. Deeksha Singh[2]
[1]MBA Dept., Model Institute of Engineering and Technology (MIET), Jammu, Jammu and Kashmir.
[2]MBA Dept., Model Institute of Engineering and Technology (MIET), Jammu, Jammu and Kashmir.
[1]parul.mba@mietjammu.in
[2] deeksha.mba@mietjammu.in

***Abstract*— The study investigates how Generation Z students' participation in private colleges in the Delhi NCR region of India is affected by technostress. Students who primarily rely on technology for their education are particularly sensitive to technostress due to the growing usage of information and communication technology (ICT) in academic activities. Students studying engineering and non-engineering completed a questionnaire that was used to gather data from 467 respondents between the ages of 18 and 23. The study used the 20-item Heilporn et al. (2020) scale to assess student participation in terms of behavioral, social, and emotional elements and the 21-item Tarafdar et al. (2007) scale to measure technostress. Significant variations in technostress levels according to gender, age, and academic discipline were found via statistical analysis. Higher levels of technostress were seen in female students, younger students (18–20 years old), and non-engineering students. Technostress and student involvement were found to be positively correlated by regression analysis, with behavioral engagement being most affected (variation of 21.6%). The study emphasizes the necessity of focused interventions to support students in managing their technology-related stress and continuing their academic participation. Educators and institutions' primary focus should be creating strategies to mitigate the harmful effects of technostress, particularly for vulnerable groups such as women, younger students, and students pursuing degrees other than engineering. These results add to the expanding body of research on technostress and highlight how crucial it is to address this problem in order to improve student engagement in the digital age.**

***Keywords*— Gen Z; Student Engagement; Technostress**

ICTIEE* Track*: Technology Enhanced Learning
ICTIEE Sub-Track: Navigating the Tech-Enhanced Learning Landscape: Challenges and Solutions

I. INTRODUCTION

Digital technology has brought about an irreversible shift in the educational landscape, ushering in an era characterized by dynamic learning environments and unmatched access to information (Bond et al., 2021). When properly incorporated into instructional strategies, technology can have a major positive impact on student engagement. Learning can be more interesting and pleasurable by utilizing interactive resources like instructional games, simulations, and virtual labs. These resources can help make difficult subjects simpler to understand and meet different styles of learning. Students can instantly access an array of materials through online resources and digital libraries, which supports independent study and research (Wang & Woo, 2021). Students can collaborate on assignments using collaborative platforms even when they are not physically present, which promotes communication and teamwork (Johnson et al., 2024). Technology certainly possesses the power to significantly enhance both educational methods and student experiences (Selwyn, 2022). But extensive technology use has also resulted in a novel and challenging issue: techno-stress. This condition, which is particularly prevalent in Generation Z, is characterized by psychological pressure brought on by excessive technology use, constant connectivity, and an inability to unplug (Kwon et al., 2023). Technology can be a useful tool for raising student engagement, but using it excessively can have several negative repercussions. Prolonged use of technology can cause "technostress," a condition linked to several psychological and physical disorders, including sadness, anxiety, insomnia, and cognitive deterioration (Ribaucourt et al., 2018). These problems may majorly affect students' capacity for focus, learning, and active engagement in their education.

Since they were raised in a technologically advanced environment and are digital natives, Generation Z is probably more susceptible to the harmful effects of techno-stress. The high rate of technology use among Generation Z has been linked to a higher risk of mental health conditions like anxiety and depression, per research by Twenge et al. (2019). The findings of Kwon et al. (2023) also confirm that this generation experiences higher levels of techno-stress due largely to their constant connection and pressure to keep up with technological advancements. Additionally, Montag and Walla's (2020) study highlights how Gen Z's dependence on technology for day-to-day tasks like social interaction and information retrieval makes them more susceptible to techno-stress, which shows up as challenges with time management, prioritization, and maintaining a realistic perspective. This generation has been accustomed to using technology extensively for

Dr. Parul Sharma
MBA Dept., Model Institute of Engineering and Technology (MIET), Jammu, Jammu and Kashmir
parul.mba@mietjammu.in

communication, entertainment, and information search. While these digital skills are helpful, excessive use of technology can lead to issues with social interaction, time and priority management, and a warped sense of reality (Twenge et al., 2019). This may increase Gen Z students' susceptibility to the detrimental impacts of tech-stress, including disengagement, procrastination, and challenges in the classroom. More research is required to fully grasp the subtle implications of excessive technology use, particularly for children in Generation Z, despite prior studies demonstrating the importance of digital

technology in increasing student engagement. This research vacuum is particularly noticeable when considering techno-stress, a condition that has been demonstrated to have a detrimental effect on learning and mental health and is aggravated by constant connectivity and excessive technology use (Twenge et al., 2019; Kwon et al., 2023). Although Gen Z students may be stressed by technology, the impact on their engagement may vary according on their academic concentration. For instance, because they use technology so often for design projects and problem-solving, engineering students may encounter particular difficulties, but they may also be better able to handle them because of their experience with digital tools (Ragu-Nathan et al., 2008; Tarafdar et al., 2011). On the other hand, students in non-technical fields could encounter various types of techno-stress, especially in relation to social pressures and diversions. Notwithstanding these differences, Johnson et al. (2024) have observed a general increase in techno-stress among students, which highlights the urgent need for more research on the subject's effects on student engagement. To guarantee that every student has a well-rounded and effective learning environment, it is imperative to address this research gap.

II. Review of Literature

Academicians now deal with Generation Z, also known as post-millennials, I Generation, and digital natives; this group of people was born after 1997.

This tech-savvy generation who are attending colleges and universities heavily relies on technology such as computers, laptops, and tablets, accessing course content through learning management systems (LMS) and using educational apps like Quiz, Nearpod, Mentimeter, etc, to enhance their academic engagement. They use technology extensively and rely on it to meet their educational demands, which can occasionally result in technostress. Numerous studies on technostress have been conducted in the past, but very little has been done to examine the level of student engagement in the field of education (Wang, X.; Tan, S.C.; Li, L, 2020; Verkijika, S.F., 2019). Therefore, this study can contribute to analyzing the concept of technostress among Gen Z and its impact on student engagement.

A. Person Environment Theory

The person-environment hypothesis, proposed by French and colleagues (French et al., 1974) suggests that the relationship between technostress and student engagement can be understood through the interaction between individual characteristics and the surrounding environment. This relationship theory is based in Kurt Lewin's (Lewin, 1951) assertion that behavior is influenced by both personal factors and environmental conditions. This theory emphasizes that disparities between individual abilities and environmental demands can significantly impact student experiences in technology-enhanced learning environments (Tang et al., 2018). The optimum outcomes arise when there is a strong alignment between an individual's characteristics, i.e., student engagement level, and the environment, i.e., technology in which they work. A good fit is linked to increased student engagement level, while a misfit can lead to stress and poor performance. Technostress, as it pertains to higher education, is the stress that students encounter as a result of the demands of technology, especially while interacting with different digital tools and platforms.

This stress often emerges when there is a disconnection between students' technological skills and abilities to cope with their learning environment. Such misalignments can lead to feelings of overload, complexity, insecurity, and uncertainty, adversely affecting student satisfaction and engagement. The implications of the P-E fit theory on student engagement are thoughtful. When students face technostress stemming from a misfit between their abilities and the technological demands of their educational environment, their academic engagement can diminish. This often results in reduced motivation, lower satisfaction with the learning experience, and ultimately poorer academic performance. Conversely, a well-aligned environment that supports students' technological capabilities can enhance their engagement and academic success. In conclusion, the P-E fit theory provides an essential foundation for comprehending how technostress affects student involvement.

B. Technostress among students

The word "technostress," which describes the psychological distress or stress people experience as a result of their increasing reliance on technology, was first used by Craig Brod in 1984 (Saleem F et al. 2024). The term "techno-overload," "techno-invasion," "techno-complexity," "techno-insecurity," and "techno-uncertainty" refers to five sub-factors that make up this complex issue (Raghunathan, 2008). Techno-overload means a situation that requires students to work faster for long hours (Tafadar,2017) to complete their work. Techno-invasion indicates the state of invasion that creates hurdles between learning and personal situations (Tafadar,2017). Techno-complexity is a situation that stimulates feelings of insufficiency and inconsistency between technological demands and present skills(Safdar,2017), and Techno-insecurity prompts feelings of insecurity based on the state of mind where one feels incapable and misfit with technology (Safadar,2017). Researchers are currently debating how technology affects students in higher education (Aziz, N. et al., 2021). Despite the pervasiveness of digital technology in modern culture, the problem of technology-related stress

remains relatively unexplored (Brooks S., Califf C., 2017). This viewpoint, however, might not apply to young students who use technology for leisure or special interests. Instead, stress is brought on by students who use technology extensively for educational purposes (Hung W. et al., 2015). Despite having a high level of self-efficacy in digital technology and having grown up in the digital age, members of Generation Z experience technostress due to the rapid advancement of digital technology (Y.-K. Lee, 2021). Consequently, this study aims to determine the prevalence of technostress and how it varies among students. The literature pays little attention to the technostress that students face (Upadhyaya & Vrinda, 2021). The present study will examine at how the five technostressors affect both engineering and non-engineering students in this study. Research indicates that students in the social sciences face higher levels of techno-complexity compared to their counterparts in engineering and natural sciences (Wang, X et.al, 2021). According to a different study by Hill (2016), students who have studied science and engineering are more likely than those who have studied social science to indicate a noticeably larger preference for a technological approach that stresses logic and reasoning. In their 2020 study, Wang et al. examined technostress in students studying engineering and the humanities. They discovered that while engineering students experience higher levels of technostress because they must learn various technologies, humanities students may use technology more frequently for research and communication, leading to lower levels of technostress associated with technological difficulties (Saleem F, Chikhaoui E, and Malik MI,2024). Thus, suggesting the need to study the below hypothesis:

H1: The degree of technostress experienced by engineering and non-engineering students differs significantly.

Research on technostress has given diverse results regarding gender differences among students. Some studies indicate that female students experience higher technostress levels than their male counterparts (Deepa Sethi et al.,2021). However, other research suggests that there may be no significant difference in technostress levels among male and female students as today's generation is well-acquainted with technology. However, findings from Tarafdar et al. (2014); Raghu-Nathan et al., (2008) reveal that male students may experience higher levels of technostress than females as females exhibit more positive attitudes toward learning and adapt better to technological changes in education (Wang et al., 2009). Moreover, Aziz (2024) posits that male students tend to focus more on the extrinsic aspects of technology use, which can lead to decreased technostress as their confidence in using computers increases. This contrasts with previous studies by Jena & Mahanti (2014) and Morales-Rodríguez (2021), highlighting the influence of gender on technostress and its impact on academic performance (Azman & Yusoff, 2018). Therefore, this suggests the need for further investigation into how gender influences technostress in educational settings among engineering and non-engineering students.

H2: There is a notable distinction in the degree of technological stress experienced by male and female students.

Research by Hauk et al. (2019) indicates a positive correlation between age and technostress levels. A study by Ragu-Nathan et al. (2008) found that technostress generally diminishes with age. Another study by Qi, (2019) also emphasizes that young learners demonstrate a considerable dependence on technology for leisure and personal interests; however, they face technostress when technology is extensively employed for educational purposes. Furthermore, a meta-analysis conducted by Hauk et al. (2018) found that older persons have greater tech-related challenges than younger adults. According to Vrinda (2020) and Upadhyaya (2020), senior postgraduate students perceive technology as being more complicated. This study aims to investigate the following hypotheses regarding students who are divided into two age groups (18–20 and 21–23 years) based on the prior literature research:

H3: The amount of technostress exhibited by engineering and non-engineering students in different age groups varies significantly.

C. Technostress and Student Engagement

Numerous definitions of student engagement exist, each offering a psychological, social, or cultural perspective (Fredricks et al., 2004; Wimpenny & Savin-Baden, 2013; Zepke & Leach, 2010). Student engagement is described as a "individual psychological state" by Kahu (2013), which encompasses a student's behavioral, social, and emotional engagement. Behavioral engagement is characterized by active participation in learning activities and is influenced by students' attitudes and interests (Kahu, 2013; Skinner,2016). Emotionally engaged students respond affectively to activities in the classroom, such as by displaying positive affect, which suggests that they are enjoying the courses, according to Van Uden, Ritzen, and Pieters (2014). Positive responses and peer interactions, along with a sense of connection or belonging, are associated with social engagement in higher education courses (Deng et al., 2020; Heilporn, et al., 2021; & B´elisle, 2022; Heilporn, et al. 2020; Ze et al., G, 2021; Pepple, 2022; Redmond et al., 2018).

Student engagement is regarded as essential to the efficient operation of educational systems in higher education (Kahu & Nelson, 2018; Pepple, 2022). Educational institutions have come to realize that technology can be a valuable tool for enhancing learning opportunities and getting students involved in the classroom. Additionally, Chen et al. (2010) discovered a favorable correlation between student engagement and technological use. Andrew et al. (2018) stressed that students discover enjoyment while using diverse forms of technology such as iPads, tablets, laptops, and smartphones to enhance the learning experience (Zinan & Sai,2017) which can promote innovation, active participation, and preparedness for future challenges while enabling them to set new goals. Ghavifekr and Rosdy (2015) identified that technological challenges

encountered in educational institutions hamper the effective utilization of technological innovations thus causing frustration among the students, developing a negative attitude towards technology. Further, merely integrating technology in classrooms does not necessarily enhance students' engagement (Schwarz&Zuhu,2015) but sometimes creates stress among the students. Reduced student engagement and motivation is one of the key detrimental effects of technostress (Saleem F, Chikhaoui E, and Malik MI, 2024). Not much research has been done in the past to study the relationship between technostress and student engagement (Jung, Kudo, & Choi, 2012). Thus, creating a need to study how technostress impacts the engagement level among engineering and non-engineering students in higher education Institutes. According to Upadhyaya and Vrinda (2021), students who suffer from

technostress are less likely to engage in online forums, communicate with their teachers and peers, and turn in their assignments on time. Lower learning quality and a drop in academic performance may result from this lack of involvement. Despite the widespread significance of technostress, previous research on students has only examined its effects on productivity and academic achievement (Tarafdar, D'Arcy et al., 2015; Tarafdar et al., 2010), not on the degree of student engagement.

Thus, the above literature creates a need to study the below-mentioned hypothesis:

H4: Student Engagement and Technostress are positively correlated

III. Research Methods

The study was conducted in private colleges in India's Delhi NCR area. These universities make substantial use of information and communication technology (ICT) for both teaching and evaluation, therefore integrating it fully into their academic processes. The study aimed to discover how technology has created technostress among students and impacted their engagement level. It focuses on establishing a relationship between technostress and student engagement. A 21-item scale proposed by Tarafdar et al. (2007) was used to measure Technostress. The items were measured using a five-point Likert scale.

Student engagement was assessed using the 20-item Heilporn et al. (2020) scale, which comprises three factors: 9 for emotional-cognitive engagement, 5 for social engagement, and 6 for behavioral engagement.

The research questionnaire was distributed among 600 students through emails using Google form to collect the data from engineering and non-engineering students, including (BBA/B.COM/BSc/B.A, etc.). A total of 467 respondents, or 77.8% of the 600, were deemed useful for analysis. The sample's respondents were between the ages of 18 and 23, with 53% of the students falling into the 18–20 age range and 47% into the 21–23 age range. Of the students who responded, 52% were female and 48% were male. Of the students, 44% were in the engineering discipline, and 56% were not in it.

A. Data Interpretation and results

This study's examination of the data is essential for coming to conclusions regarding the connections between technostress and student engagement level. The data analysis has been done using the Statistical Package for the Social Sciences (SPSS) version 24.0. Independent t-test, Anova and regression analysis have been used to analyze the data. The independent t-test has been used to study the relationship between male and female population, their age group and discipline whereas anova and regression analysis have been used to explore the impact of one variable over the other.

Reliability: The Cronbach's alpha coefficient is commonly used to assess the internal consistency of items within a construct; a value of 0.7 or higher indicates excellent reliability.

Every construct in our investigation complied with this condition i.e. overall composite reliability ($\alpha = 0.917$), technostress $\alpha = 0.754$, emotional engagement $\alpha = 0.858$, behavioral engagement $\alpha = 0.856$ and social engagement $\alpha = 0.797$ depicting that scale is reliable.

Validity: Measures of construct and content validity have been conducted to assess the scale's validity. The content validity of the scale has been established by an extensive assessment of the literature and consultation with specialists.

TABLE I
STATISTICS FOR MEASUREMENT ITEMS RELIABILITY

Construct	No. of Items	Cronbach alpha	Means	Standard Deviation
Technostress	21	0.754	3.123	0.836
Emotional Engagement	9	0.858	3.65	1.296
Behavioral Engagement	6	0.856	3.5	1.309
Social Engagement	5	0.797	3.61	0.145

H1: The degree of technostress experienced by engineering and non-engineering students differs significantly.

An independent sample t-test was used to find out if students with different academic backgrounds experience significantly higher levels of technostress. Table 3 presents the results, comparing the levels of technostress experienced by engineering and non-engineering students (t: 2.051, $p < 0.05$) suggests that the level of technostress differs among engineering and non-engineering students. Further, the result shows that the engineering students ($\bar{x}=3.236$) have higher technostress than non-engineering students($\bar{x}=3.127$). Thus, it indicates that the requirement of technology may affect students differently depending on their academic focus. Further, various studies supported that the technostress level is high among art students as compared to science students (Mahapatra et al,2023) but the current study does not support this argument. Therefore,

the results support H1.

H2: The amount of technostress experienced by male and female students differs significantly.

The study employed an independent sample t-test to investigate the presence of noteworthy levels of technostress in the student group according to gender. Table 3 presents the data and compares the levels of technostress experienced by male

and female students (t:1.814, $p < 0.05$) suggesting that the level of technostress differs among male and female students. Mean value of males ($\bar{x}$=3.129) is lesser than females ($\bar{x}$=3.215) suggesting that technostress is higher among female than male. Further, the results of the various previous studies (Aziz, N.N.A et.al,2024;Wang et.al, 2019) also suggest that technostress effects vary significantly for male and female students. Female students face more technostress than males. Therefore, supporting H2.

H3: A notable distinction exists in the degree of technostress experienced by engineering and non-engineering students across various age cohorts.

A t-test for independent samples was used to determine whether students in age-based groups had significant levels of technostress. A comparison of technostress levels across age groups (t:2.657, $p < 0.05$) in Table 3 illustrates the findings and shows that there are differences in technostress levels across students.

Further, the mean value ($\bar{x}$=3.231) of the age group 18-20 years suggests that young students have higher technostress as compared to the older age group. The study conducted by (Upadhyaya, 2021; Ragu-Nathan,et.al,2008; Ayyagari, R.,2011) supports the argument that younger students may be more vulnerable to technostress, perhaps due to factors such as increased dependency on technology usage for education, social interactions, and other activities. Therefore, supporting H3.

TABLE II
RESULT OF T-TEST ANALYSIS

Construct	Technostress Mean value	t-value	Significance level
Gender			
Male	3.129	1.814	0.03*
Female	3.215		
Age	3.231		
18-20	3.094	2.657	0.008*
21.2			
Discipline			
Engineering	3.236	2.051	0.033*
Nom-Engineering	3.127		

*p<0.05

H4: Technostress and student engagement have a positive correlation.

The relationship between students' conduct, social and emotional engagement, and regression analysis was examined.

The results the ANOVA test (Table 4) suggest that the p-value <0.05, depicting that it is statistically significant(p=000), thus there exists a linear relation between technostress and student behavioral engagement. Further, regression analysis results indicate that R^2 value is 0.216 from Table 4 emphasizing that technostress leads to 21.6% variation in the behavioral engagement of students. Further, the beta coefficient value from Table 4 signifies that technostress has a positive relationship with students' behavioral engagement $\beta = 0.464$, $p = 000$. Thus, the study's conclusions imply that students' behavioral engagement is impacted by rising levels of technostress.

Additional findings (table 4) examine the connection between students' emotional engagement behavior and their level of technostress. The results of the ANOVA test (table 4) suggest that the p-value <0.05, depicting that it is statistically significant(p=000), thus there exists a linear relation between technostress and student emotional engagement level. Further, regression analysis results indicate that R^2 value is 0.191 from Table 4 emphasizing that technostress leads to 19% variation in the emotional engagement level of students. Further, the beta coefficient value from Table 4 signifies that technostress has a positive relationship with students' emotional engagement $\beta = 0.334$, $p = 000$. Therefore, the findings of the study suggest that the increase in the level of technostress impacts behavioral engagement among students.

The Table 4 regression analysis results also explore the connection between students' social engagement behavior and technostress. The results of the ANOVA test (table 4) suggest that the p-value <0.05, depicting that it is statistically significant(p=000), thus there exists a linear relation between technostress and student social engagement level. Further, regression analysis results indicate that R^2 value is 0.134 from Table 4 emphasizing that technostress leads to 13.4% variation in the social engagement level of students. Further, the beta coefficient value from Table 4 signifies that technostress has a positive relationship with students' social engagement $\beta = 0.201$, $p = 000$. Therefore, the findings of the study suggest that the increase in the level of technostress impacts social engagement among students.

Among emotional engagement, social engagement, and behavioral engagement, it is behavior engagement (r=0.464; r2= 0.216) is highly impacted by technology stress. Behavioral engagement comprehends the active participation of students in learning activities and their determination when faced with challenges. However, technostress can adversely affect this engagement by reducing students' involvement in learning tasks and hindering their ability to concentrate during technology-enhanced instruction.

TABLE III
RESULT OF REGRESSION ANALYSIS

Construct	R	R Square	Adjusted R Square
Emotional Engagement	0.334	0.191	0.189
Social Engagement	0.201	0.134	0.130
Behavioral Engagement	0.464	0.216	0.214

Predictor: (Constant), Technostress

TABLE IV
RESULTS OF BETA COEFFICIENTS

Construct	Standardized Coefficients Beta	Significance
Emotional Engagement	0.334	0.000
Social Engagement	0.201	0.000
Behavioral Engagement	0.464	0.000

Predictor: (Constant), Technostress

Based on the aforementioned analysis, the study's findings show that technostress in the classroom significantly impacts student engagement. Although Generation Z is tech-savvy, they need effective coping strategies to adapt to the rapidly evolving technological landscape. Non-engineering students, females, and those aged 18-20 are particularly vulnerable to technostress, which can hinder their academic performance and overall engagement. While this generation heavily relies on technology, fostering engagement remains a considerable challenge for educators. Among emotional, social, and behavioral dimensions, behavioral engagement is most profoundly affected by technostress. It is critical to practice strategies that give kids coping skills, create interesting teaching methods that reduce stress, and foster an environment in the classroom that supports open communication to address these issues.

By focusing on these areas, educators can enhance student engagement and help students navigate the pressures of technostress effectively.

IV. Discussion

Technostress has become a serious issue in the digital age, affecting people's lives in many ways, especially for students. The effects of technostress vary greatly depending on age, gender, and academic discipline. This conversation delves into the effects of technostress on students, emphasizing age gaps, gender inequalities among Generation Z, and distinctions between engineering and non-engineering students. We also look at the impact of technostress on Gen Z's emotional behavior, social engagement, and behavioral engagement.

Different age groups experience technostress in different ways; younger students, especially those from Generation Z, who are in the 18–20 age range, seem to experience it more severely. Born between the middle of the 1990s and the beginning of the 2010s, Generation Z has grown up in a time when digital technology is the norm. Despite its many positive effects, this widespread use of technology has raised the prevalence of technostress. The pressures of constantly being connected and online might overburden students, which can negatively affect their social networks, academic performance, and anxiety (Ragu-Nathan et al., 2008). Research shows that younger people are more vulnerable than older generations to the demands and difficulties presented by technology (Ayyagari et al., 2011). This phenomenon is consistent with this finding.

Moreover, there is a significant gender difference in the way that Generation Z experiences technostress. The findings show that, in comparison to their male peers, female students usually experience higher levels of technostress. Numerous factors, including as variations in technology usage habits and the kinds of stressors encountered, can be blamed for this. However, because they utilize and engage with technology in various ways, male students may feel technostress in a different way. The necessity for specialized measures to handle the particular difficulties that each gender faces is highlighted by the disparities in technostress across the sexes (Ragu-Nathan et al., 2008).

The academic fields of students have a considerable impact on the impact of technostress. Compared to their classmates in other fields, engineering students report higher levels of technostress due to their frequent exposure to technology-intensive workplaces. This disparity can be attributed to engineering curricula's strong emphasis on technology and its applications, which exposes students to more stressful technological demands. According to Huang et al. (2013), engineering students often work with sophisticated software, analyze large amounts of data, and solve challenging problems. These activities can make them feel more stressed out due to technology. On the other hand, non-engineering students might experience technostress less often because they place less emphasis on technology in their academic endeavors, even though they are still susceptible to it. The necessity of discipline-specific interventions to reduce technostress is highlighted by this variation (Chen & Karahanna, 2014).

Beyond personal experiences, behavioral and emotional aspects of technostress are also impacted. According to the findings, 21.6% of the effects on pupils in Generation Z's behavioral engagement can be attributed to technostress. Students' participation in class, academic activities, and general dedication to learning are all included in their behavioral engagement. According to Tarafdar et al. (2010), there is evidence that students who experience high levels of technological stress are less motivated and open to participating in learning activities, which can ultimately lead to decreased academic performance and engagement.

Due to the ubiquitous nature of technology and the pressures it causes, kids may find it difficult to concentrate, which will lower their academic performance and engagement.

Technostress also affects emotional behavior; it accounts for around 19.1% of the total impact. The psychological reactions and emotional states that people go through, like stress, worry, and annoyance, are referred to as emotional behavior. Students of Generation Z may experience increased emotional distress as a result of the ongoing strain of handling several digital platforms and negotiating online interactions. According to Ayyagari et al. (2011), emotional pressure can cause anxiety, burnout, and mood swings, which can further harm students' general well-being and academic engagement.

A multifaceted strategy that takes into account the diverse experiences of various student groups is necessary to address technostress. Policymakers and educational institutions must put policies into place that specifically address the requirements of various demographic groups. For instance, reducing the stress brought on by digital demands can be achieved by offering instruction and materials to assist students in properly managing their use of technology. Furthermore, fostering welcoming settings that facilitate candid conversations on technology-related stress and its effects can aid in lowering stigma and advancing students' mental health (Gorgievski et al., 2010).

Finally, it should be noted that students of all ages, genders, and academic disciplines are particularly affected by technostress. Students in Generation Z, who are especially susceptible to the demands of constant connectedness, suffer from behavioral and emotional problems as a result of technostress. While disparities between engineering and non-engineering students emphasize the significance of discipline-specific techniques, gender inequalities also highlight the necessity for customized interventions. Educational institutions can better support students in managing technostress and improving their overall student engagement by comprehending and resolving these various experiences.

.

V. Implications

Theoretical Implications

The experiences of Generation Z, who confront elevated stress levels due to continual digital connectedness, must be taken into account for theoretical improvements in understanding technostress. According to research by Ayyagari et al. (2011) and Ragu-Nathan et al. (2008), persistent online participation negatively impacts this demographic's psychological well-being and academic engagement. Significant gender differences in technostress are also visible, with female students reporting higher levels of stress as a result of social media pressures from society (Turel et al., 2011). To give a more thorough knowledge of technostress, future theoretical models should consider these gender-specific stressors. Moreover, there are notable differences in the effects of technostress among academic fields. Students studying engineering report higher levels of stress than their colleagues studying other fields since they are often using sophisticated technology tools (Huang et al., 2013). Based on these data, disciplinary-specific theoretical models are needed to explain how various academic activities and tech-heavy surroundings lead to distinct degrees of technostress.

Social Implications

Creating more inclusive and supportive learning settings is imperative due to the societal repercussions of student technostress. Educational institutions can create peer mentorship programs to assist younger students in properly managing digital demands and stress by taking into account the particular issues that Generation Z faces (Gorgievski et al., 2010). The differences in technostress between genders highlight the necessity for gender-sensitive therapies. To address the issues female students, face, like social media pressures, schools can host workshops on digital literacy and mental health (Turel et al., 2011). According to Chen and Karahanna (2014), peer support groups can facilitate the sharing of experiences and coping methods among students in technology-intensive disciplines such as engineering. This can effectively mitigate feelings of stress and isolation.

Managerial Implications

The creation and implementation of concrete execution strategies that reduce students' technological stress must be a top priority for educational institutions. Students can effectively manage their technology use with the support of balanced technology use restrictions, such as screen time limitations and occasional technological detoxes (Ayyagari et al., 2011). Reducing screen dependency and increasing student engagement can be achieved by including collaborative, practical projects into curricula and offering digital well-being courses, especially within technology-driven fields (Huang et al., 2013). Additionally, giving students easy access to mental health resources—like stress management training and counseling catered to their individual needs—is essential in empowering them with effective ways to cope (Tarafdar et al., 2010). Educational institutions can further address technostress by providing training to staff members on how to identify and assist impacted students, facilitating mental health care referrals, and introducing conversations about technology use and use and mental well-being into classroom activities (Gorgievski et al., 2010).

Future Implications

The increasing incidence of technostress among students necessitates a thorough, multidimensional strategy to lessen its effects and improve student well-being. It is imperative that educational establishments implement a well-balanced approach to technology integration, highlighting digital well-being in the curriculum and encouraging digital detox periods and hybrid learning methods. Prioritizing mental health care with easily available tools and gender-sensitive interventions can help address the particular difficulties faced by female engineering students. Understanding technostress and developing focused solutions require ongoing research and observation. The creation of realistic management tools and user-friendly educational technologies can be facilitated by collaboration between educational institutions and the tech industry. Teachers must receive training on identifying and managing technostress and incorporate conversations on digital well-being into their lesson plans. Broader policy lobbying can support research, establish screen time standards, and advance curricula for digital well-being. Collaborating globally and exchanging optimal methodologies will augment approaches to

assist learners globally in directional the digital terrain in a wholesome and efficient manner.

LIMITATIONS

It is challenging to extrapolate the findings of this study to other student demographics due to the differences in cultural backgrounds. Furthermore, an online questionnaire was used to collect the necessary data; as a result, qualitative research methods may be used in further studies to obtain more insightful findings. Technostress inhibitors are an important element frequently disregarded, and demographic variations beyond basic features are seldom thoroughly investigated. These deficiencies need to be addressed in future research to better understand technostress and its impact on student engagement.

CONCLUSION

To sum up, technostress is a complex problem that significantly impacts Generation Z students in many areas, such as academic discipline, age, gender, and behavioral and emotional participation. Although the digital age has many advantages, it also presents serious difficulties, especially for younger pupils who must continually adjust to the demands of technology. The results show that Generation Z, particularly those between the ages of 18 and 20, suffers from technostress more severely, which has an effect on their mental health, social relationships, and academic achievement. The problem is exacerbated by gender differences; as female students typically experience higher levels of technostress than their male counterparts. This distinction emphasizes how gender-sensitive methods of managing technostress are essential.

Furthermore, their academic specialty is a significant factor in how students perceive technostress. Students studying engineering are especially vulnerable since they depend heavily on technology and are subject to demanding technological requirements. On the other hand, non-engineering students encounter technostress to a lesser extent, albeit still being impacted. This variation emphasizes the value of discipline-specific therapies that address the particular difficulties encountered by students in various fields.

Technostress substantially impacts Generation Z's emotional and behavioral participation, even in addition to academic expectations. In addition to increased emotional distress, the decline in motivation, involvement, and overall academic engagement highlights the need for comprehensive interventions to alleviate the detrimental consequences of technostress. Legislators and educational institutions alike need to make it a top priority to establish welcoming spaces with tools and instruction for smart digital use. Institutions may better assist students' well-being and ultimately improve their academic and personal performance in an increasingly digital environment by acknowledging and addressing the different experiences of their students

REFERENCES

Arnetz, B. B., & Wiholm, C. (1997). Technological stress: Psychophysiological symptoms in modern offices. *Journal of Psychosomatic Research*, 43(1), 35-42.

Ayyagari, R., Grover, V., & Purvis, R. (2011). Technostress: Technological antecedents and implications. *MIS Quarterly*, 35(4), 831-858.

Aziz, N. N. A., Kader, M. A. R. A., & Halim, R. A. (2021). The impact of technostress on student satisfaction and performance expectancy. *Asian Journal of University Education*, 17(4), 538-552.

Azman, N., & Yusoff, H. M. (2018). Pencapaian akademik murid lelaki dan perempuan: Peranan sokongan pembelajaran dan keterlibatan murid. *Malaysian Journal of Learning and Instruction*, 15(2), 257-287.

Barnacle, R., & Dall'Alba, G. (2017). Committed to learn: Student engagement and care in higher education. *Higher Education Research & Development*, 36(7), 1326-1338.

Belisle, A. C., et al. (2022). Integrating Indigenous and scientific perspectives on environmental changes: Insights from boreal landscapes. *People and Nature*.

Bond, M., Marín, V. I., Dolch, C., Bedenlier, S., & Zawacki-Richter, O. (2021). Digital transformation in German higher education: Student and teacher perceptions and usage of digital media. *International Journal of Educational Technology in Higher Education*, 18(1), 1-22.

Brod, C. (1984). *Technostress: The human cost of the computer revolution*. Basic Books.

Brooks, S., & Califf, C. (2017). Social media-induced technostress: Its impact on the job performance of IT professionals and the moderating role of job characteristics. *Computers in Human Behavior*, 114, 143-153.

Chen, A., & Karahanna, E. (2014). Boundaryless technology: Understanding the effects of device usage habits and boundary management practices on the interruption-based technostress. *Journal of the Association for Information Systems, 15*(4), 178-203.

Deng, R., Benckendorff, P., & Gannaway, D. (2020). Learner engagement in MOOCs: Scale development and validation. *British Journal of Educational Technology, 51*(1), 24.

Pepple, D. G., & Dore-Okuiomse, M. M. (2023). An enabler framework for developing knowledge management practices: Perspectives from Nigeria. *SA Journal of Information Management, 25*(1).

Fredricks, J., Blumenfeld, P., & Paris, A. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research, 74*(1), 59–109.

French, J. R. P., Jr., Rodgers, W. L., & Cobb, S. (1974). Adjustment as person-environment fit. In G. Coelho,

D. Hamburg, & J. Adams (Eds.), *Coping and adaptation* (pp. 316–333). Basic Books.

Ghavifekr, S., & Rosdy, W. A. W. (2015). Teaching and learning with technology: Effectiveness of ICT integration in schools. *International Journal of Research in Education and Science (IJRES), 1*(2), 175-191.

Gorgievski, M. J., Bakker, A. B., & Schaufeli, W. B. (2010). Work engagement and workaholism: An integrative model. In S. L. Albrecht (Ed.), *Handbook of employee engagement: Perspectives, issues, research and practice* (pp. 68-78). Edward Elgar.

Hauk, N., Goritz, A. S., & Krumm, S. (2019). The mediating role of coping behavior on the age-technostress relationship: A longitudinal multilevel mediation model. *PLoS One, 14*(3), e0213349.

Hauk, N., Hüffmeier, J., & Krumm, S. (2018). Ready to be a silver surfer? A meta-analysis on the relationship between chronological age and technology acceptance. *Computers in Human Behavior, 84*, 304–319.

Heilporn, G., Lakhal, S., & Bélisle, M. (2021). An examination of teachers' strategies to foster student engagement in blended learning in higher education. *International Journal of Educational Technology in Higher Education, 18*.

Heilporn, G., Lakhal, S., & Bélisle, M. (2021). An examination of teachers' strategies to foster student engagement in blended learning in higher education. *International Journal of Educational Technology in Higher Education, 18*.

Heilporn, G., Lakhal, S., Bélisle, M., & St-Onge, C. (2020). Student engagement: A multidimensional measurement scale applied to blended course modalities at the university level. *Mesure et évaluation en éducation, 43*(spécial), 1-31.

Hill, F., Tomkinson, B., Hiley, A., & Dobson, H. (2016). Learning style preferences: An examination of differences amongst students with different disciplinary backgrounds. *Innovative Teaching and Learning, 53*, 122–134.

Huang, C., Zhao, W., & Wu, J. (2013). The impact of technostress on university students' performance: An empirical study. *Computers in Human Behavior, 29*(3), 899-905.

Hung, W. H., Chen, K., & Lin, C. P. (2015). Does the proactive personality mitigate the adverse effect of technostress on productivity in the mobile environment? *Telematics and Informatics, 32*(1), 56-66.

Jena, R. K., & Mahanti, P. K. (2014). An empirical study of technostress among Indian academicians. *International Journal of Education and Learning, 3*(2), 1–10. https://doi.org/10.11591/ijel.v3i2.3874

Johnson, R. D., Marakas, G. M., & Palmer, J. W. (2024). Understanding the effects of technostress on academic performance: The role of self-efficacy and motivation. *Journal of Educational Computing Research, 62*(2), 123-140. https://doi.org/10.1177/07356331221123790

Jung, I., Choi, S.-K., & Kudo, M. (2012). Instructional design strategies for stress-reduced online collaboration in Asia's high context culture. *Asian Association of Open Universities Journal, 7*(1), 35-42. https://doi.org/10.1108/16479161211246819

Kahu, E. R. (2013). Framing student engagement in higher education. *Studies in Higher Education, 38*(5), 758–773. https://doi.org/10.1080/03075079.2011.598505

Kahu, E. R., & Nelson, K. (2018). Student engagement in the educational interface: Understanding the mechanisms of student success. *Higher Education Research and Development, 37*(1), 58–71. https://doi.org/10.1080/07294360.2017.1362531

Kwon, O., Kim, S., & Sung, Y. (2023). The effects of technostress on student engagement and academic performance: A longitudinal study. *Computers & Education, 175*, 104334. https://doi.org/10.1016/j.compedu.2021.104334

Lee, Y. K. (2021). Impacts of digital technostress and digital technology self-efficacy on FinTech usage intention of Chinese Gen Z consumers. *Sustainability, 13*(9), 5077. https://doi.org/10.3390/su13095077

Lepp, A., Barkley, J. E., Sanders, G. J., Rebold, M., & Gates, P. (2013). The relationship between cell phone use, physical and sedentary activity, and cardiorespiratory fitness in a sample of US college students. *International Journal of Behavioral Nutrition and Physical Activity, 10*, 79. https://doi.org/10.1186/1479-5868-10-79

Lewin, K. (1951). *Field theory in social science*. Harper & Row.

Mahapatra, H., Bankira, S., Sahoo, N. K., & Bhuyan, S. (2023). Relationship between techno stress and academic performance of university students. *Journal of Education, Society and Behavioural Science, 36*(10), 45-55. https://doi.org/10.9734/jesbs/2023/v36i104706

Montag, C., & Walla, P. (2020). Carpe diem instead of losing your social mind: Beyond digital addiction and why we all suffer from digital overuse. *Cogent Psychology, 7*(1), 1746736. https://doi.org/10.1080/23311908.2020.1746736

Morales-Rodríguez, F. M. (2021). Fear, stress, resilience and coping strategies during COVID-19 in Spanish university students. *Sustainability, 13*(11), 5824. https://doi.org/10.3390/su13115824

Qi, C. (2019). A double-edged sword? Exploring the impact of students' academic usage of mobile devices on technostress and academic performance. *Behaviour & Information Technology, 38*(12), 1337–1354. https://doi.org/10.1080/0144929X.2019.1598010

Ragu-Nathan, T. S., Tarafdar, M., Ragu-Nathan, B. S., & Tu, Q. (2008). The consequences of technostress for end users in organizations: Conceptual development and empirical validation. *Information Systems Research, 19*(4), 417-433. https://doi.org/10.1287/isre.1080.0204

Redmond, P., Heffernan, A., Abawi, L., Brown, A., & Henderson, R. (2018). An Online Engagement Framework for Higher Education. *Online Learning,*

22(1), 183-204. https://doi.org/10.24059/olj.v22i1.1266

Ribaucourt, A., Thibault, G., & Lorant, V. (2018). Technostress in the workplace: A systematic review of empirical research. *European Journal of Information Systems, 27*(6), 671-687. https://doi.org/10.1080/0960085X.2018.1486852

Saleem, F., Chikhaoui, E., & Malik, M. I. (2024). Technostress in students and quality of online learning: Role of instructor and university support. *Frontiers in Education, 9*, 1309642. https://doi.org/10.3389/feduc.2024.1309642

Schwarz, C., & Zhu, Z. (2015). The impact of student expectations in using instructional tools on student engagement: A look through the expectation disconfirmation theory lens. *Journal of Information Systems Education, 26*(1), 47-58. https://www.jise.org/Volume26/N1/JISEv26n1p47.pdf

Selwyn, N. (2022). *Education and technology: Key issues and debates*. Bloomsbury Publishing.

Sethi, D., Gupta, A., & Sharma, R. (2021). Gender differences in technostress among university students. *International Journal of Environmental Research and Public Health, 18*(23), 12322.

Skinner, E. A., Zimmer-Gembeck, M. J., & Connell, J. P. (1998). Individual differences and the development of perceived control. *Monographs of the Society for Research in Child Development, 63*(2–3), 1–220.

Tang, J., Tsai, J. J., Liu, J., Chen, M. P., Su, C. Y., & Yen, C. F. (2018). Disparities between individual abilities and environmental demands: Impacts on student experiences in technology-enhanced learning environments. *Computers & Education, 123*, 117-128.

Tarafdar, M., Cooper, C. L., & Stich, J.-F. (2017). The technostress trifecta - techno eustress, techno distress, and design: Theoretical directions and an agenda for research. *Information Systems Journal, 29*(6), 6–42.

Tarafdar, M., Pullins, E. B., & Ragu-Nathan, T. S. (2010). Examining impacts of technostress on the professional salesperson's behavioral performance. *Journal of Personal Selling & Sales Management, 30*(1), 19-28.

Tarafdar, M., Pullins, E., & Ragu-Nathan, T. (2015). Technostress: Negative effect on performance and possible mitigations. *Information Systems Journal, 25*(2), 103–132.

Tarafdar, M., Tu, Q., & Ragu-Nathan, T. (2010). Impact of technostress on end-user satisfaction and performance. *Journal of Management Information Systems, 27*(3), 303–334.

Tarafdar, M., Tu, Q., Ragu-Nathan, B. S., & Ragu-Nathan, T. S. (2007). The impact of technostress on role stress and productivity. *Journal of Management Information Systems, 24*(1), 301–328.

Tarafdar, M., Tu, Q., Ragu-Nathan, B. S., & Ragu-Nathan, T. S. (2011). Crossing to the dark side: Examining creators, outcomes, and inhibitors of technostress. *Communications of the ACM, 54*(9), 113-120.

Turel, O., Serenko, A., & Bontis, N. (2011). Family and work-related consequences of addiction to organizational pervasive technologies. *Information & Management, 48*(2-3), 88-95.

Twenge, J. M., Martin, G. N., & Spitzberg, B. H. (2019). Trends in US adolescents' media use, 1976–2016: The rise of digital media, the decline of TV, and the (near) demise of print. *Psychology of Popular Media Culture, 8*(4), 329-345.

Upadhyaya, P. (2021). Impact of technostress on academic productivity of university students. *Education and Information Technologies, 26*, 1647–1664.

Van Uden, J. M., Ritzen, H., & Pieters, J. M. (2014). Engaging students: The role of teacher beliefs and interpersonal teacher behavior in fostering student engagement in vocational education. *Teaching and Teacher Education, 37*, 21–32.

Verkijika, S. F. (2019). Digital textbooks are useful but not everyone wants them: The role of technostress. *Computers & Education, 140*, 103591.

Wang, T., & Woo, H. L. (2021). Exploring the impact of using social media for promoting the growth mindset on academic engagement in a COVID-19 learning environment. *Educational Technology Research and Development, 69*(3), 211-226.

Wang, X., & Fan, H. X. (2009). Report of present situation of study adaptability of university students. *Theory and Practice in Education, 29*, 62–64.

Wang, X., Tan, S. C., & Li, L. (2019). Technostress in university students' technology-enhanced learning: An investigation from multidimensional person-environment misfit. *Computers in Human Behavior, 105*, 106208. https://doi.org/10.1016/j.chb.2019Crouch, C. H., & Mazur, E. (2001). Peer Instruction: Ten years of experience and results. *American Journal of Physics, 69*(9), 970–977.