Analyzing the Influence of Technostress on Students: A Systematic Literature Review

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Abstract. Technostress is the stress experienced by individuals due to the use of technology. In today's digital age, students are increasingly exposed to technology, which, with many benefits, can also lead to technostress. This can harm students' overall well-being and academic performance. We thus argue that the impact of technology use on students should be better understood, and perform a systematic literature review (SLR), following the guidelines outlined in Okoli's 8-step procedure. Reviewing the articles addressing technostress among students, the findings indicate that technostress can lead to decreased focus and concentration, impaired sleep patterns, social isolation, and a decline in mental health. It can also contribute to a negative attitude towards technology, hindering students' ability to effectively leverage its potential for learning and productivity. The findings also suggest that the experience of stress is influenced by an individual's perception of a stressful situation. Different individuals may perceive the same situation as stressful or non-stressful, depending on various factors such as time, place, and personal interpretation. This SLR provides a comprehensive and dependable resource for researchers, identifies existing research gaps, and proposes directions for future investigations.

Keywords: Technostress, Education, Systematic Literature Review, Students, ICT use.

1 Introduction

The rapid adoption of Information and Communication Technologies (ICTs) has had a profound impact on organizations and individuals. The pervasiveness of ICTs has made it possible for employees to connect anytime, anywhere to support and improve organizational decision-making, leading to increased organizational performance, greater flexibility, and access to information [16]. More and more, organizational structures and processes are adapted to the characteristics of ICTs [23]. From the way we communicate and conduct business to how we access information and shape our worldviews, ICTs have become the driving force behind every facet of our lives [80].

In education, the use of ICTs has been shown to provide a significant advantage in terms of convenience and effectiveness in various aspects of students[50]. Through digital platforms and tools, they can access a vast array of information [14], explore diverse perspectives, and engage in interactive learning experiences [15] that cater to their individual needs. For example, online education enables them to acquire valuable digital skills that can enhance their job prospects. Additionally, remote access to educators and course materials makes online learning comfortable and convenient and allows for personalized learning experiences and quick assessments [35]. Furthermore, the absence of time constraints gives students greater flexibility in their learning process [3].

While its favorable aspects are often emphasized, scholars have also pointed out that the negative consequences of students' ICT use need to be recognized and addressed [51, 71]. Introducing new applications and upgrading existing ones can generate pressure and apprehension for technology users struggling to adapt to new technologies [22]. The ubiquitous characteristics of it may cause stress and imbalance in an individual's well-being and work-life balance [60]. This is studied under the term "technostress", which is stress

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experienced by individuals due to the use of ICTs [53]. Although some researchers agree that younger generations are digital natives and possess significant technological talent [11, 49], studies have shown that they are not immune to experiencing technostress [79]. To attend classes and obtain course-related information, students need to allocate an increased amount of time to using their devices and accessing internet platforms that are utilized by educational institutions. Higher education institutions have adopted platforms to share information, hold classes, and interact with students, which requires students to remain full-time connected to these online platforms [25]. The combination of factors such as limited access to high-quality internet services in some geographical areas, the requirement for adequate digital skills to use certain platforms, inadequate technology skills, and insufficient digital resources such as laptops and desktops, along with constant push notifications, interruptions, and the pressure to remain always available [34], has resulted in technostress and its adverse outcomes, including lower academic performance and productivity, higher dropout rates, and decreased focus on academic work among students [31, 67, 77].

Various studies have explored technostress and its effects on different groups, including those in the education sector [7, 31, 67], yet, most of them focused on employees, teachers [21, 31–33, 47], and library users [36, 55]. The purpose of this paper is to contribute to this field by conducting a systematic literature review (SLR) of articles addressing technostress among students. In doing so, we aim to summarize existing knowledge, identify research gaps, and propose directions for future investigations. We address the following research questions: RQ1) What are the potential consequences of technostress on students? RQ 2) Which factors/ variables affect the impact of technostress on students, and how? RQ 3) How is technostress measured among the students and which technostress-creator exerts the most significant impact on them? RQ 4) What strategies or mechanisms have been suggested to address technostress among students? Against this background, Section 2 reviews the literature, Section 3 outlines the SLR procedure we followed. The findings are detailed in Section 4 and discussed in Section 5 along with the limitations. Suggesting areas for future research, Section 6 concludes the study.

2 Background and Literature Review

2.1 Technostress and its creators

The origins of the term "Technostress" can be traced back to 1982, when clinical psychologist Craig Brod defined it as "a condition resulting from the inability of an individual or organization to adapt to the introduction and operation of new technology" [13]. From the perspective of Job Demands-Resources (JDR) Theory [9], [31] argues technostress arises due to an individual's difficulty in managing the rising demands imposed by technological advancements. As such, [53] defines technostress as "the phenomenon of stress experienced by end users in organizations as a result of their use of ICTs".

Being a concept that has been studied both in organizational and private contexts, technostress is associated with physical (muscle cramps, headaches [17], psychological (exhaustion and burnout [65], and behavioral symptoms (decreased job satisfaction and task performance, increased role overload and conflict [53, 66]. Five technostress creators are mentioned in the literature; techno-complexity ("too difficult"), techno-invasion ("always connected"), techno-insecurity ("being replaced"), techno-overload ("too much"), and techno-uncertainty ("too many changes") [43].

In line with the transactional theory of stress [37], technostress is a response to environmental stressors and is subjectively experienced. This means that two individuals can

perceive the same situation differently, leading to two opposing concepts, "techno-eustress" and "techno-distress". Techno-eustress refers to a moderate or manageable level of psychological stress that is perceived as beneficial to individuals [35], where technology can help them accomplish new objectives. Techno-distress focuses on the detrimental outcomes of ICT use, explaining "the processes by which individuals appraise IS as a threat, experience consequent 'bad' stress" [63]. From a resource perspective, individuals can combat the negative effects of technostress by incorporating coping mechanisms, i.e. "behaviors enacted to attempt to alter, change, or escape from the stressors" [48]. Tarafdar et al. offer distancing, positive IT outlook, IT use skills, autonomy, and work/non-work IT use separation as examples of coping behaviors [64].

2.2 Technostress among students

In academic settings, ICTs are subject to constant change encompassing ongoing upgrades to hardware devices, applications, systems, and the networks employed. For instance, teaching methods undergo continuous modifications with the introduction of online learning and new educational systems [27]. Consequently, the widespread utilization and constant change of these technologies for educational and learning purposes has given rise to the emergence of detrimental consequences among their users [31, 67]. At the educational level, factors that contribute to the development of technostress among students relate to the utilization of hardware devices (laptops, mobile phones, tablets) [34], as well as the usage of various tools, including social networking sites, instant messaging apps, and various other digital platforms [2, 8]. Furthermore, students are constantly confronted with the need to adapt to new and evolving technologies within limited timeframes and under considerable pressure [40]. They may encounter additional sources of tension and anxiety while engaging with ICTs throughout their learning process [72]. Some notable examples include concerns related to educational institutions' design and delivery of content and instruction, the overall learning process and assessment methods [76], and potential system errors that could arise during exams [34].

From a JDR perspective, techno-distress among students becomes apparent when the demands of ICTs go beyond their level of expertise or when their expectations exceed their capabilities or capacity to meet them [20]. It is the perceived mismatch between demands and related resources to technologies by students (e.g., technical problems, continuous updates), the misfit between students' technological abilities (i.e., their skills using ICTs, multitasking, and high workload), and the new learning environment (i.e., online environment, constant availability). However, technology also has a positive impact on academic performance [69], student achievement, motivation, and attitudes [29]. From the resources perspective, techno-eustress creates an environment where students view ICT-related stressors as opportunities rather than obstacles, enabling the development of their skills [50] and leading to sustained commitment, heightened motivation, and active participation in the learning process without any feelings of fear or hesitation [44]. It may have a transformative and pioneering role, fostering more efficient learning and teaching methods among students [51, 67, 74].

3 Methodology

Adopting an SLR approach, this paper examines the current state of the literature on the impact of technostress on students. An SLR is "a systematic, explicit, (comprehensive), and reproducible method for identifying, evaluating, and synthesizing the existing body of

completed and recorded work produced by researchers, scholars, and practitioners" [45]. This study follows Okoli's guidelines, categorizing the SLR into eight steps (see Figure 1).

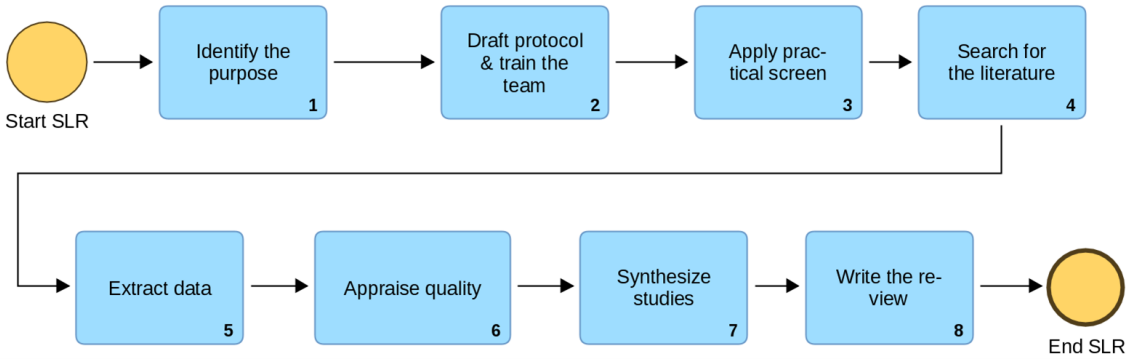

Fig. 1. SLR Procedure based on [45]

Departing from the idea of the "double-edged nature of technology" [60], and the divergent perspectives on technostress among the students, the primary objective of the study is summarizing the existing knowledge, identifying research gaps, and proposing directions for future investigations for upcoming studies. As such, we aim to offer a comprehensive and dependable resource for students, technostress researchers, as well as practitioners in the education sector.

In the 2nd step, we drafted a protocol to log the search process. The principal investigator was trained where different approaches to SLR (e.g. PRISMA, Snowballing) were shown, and examples from Information Systems (IS) literature were demonstrated and discussed. As for the practical screen, we decided to conduct the search utilizing three databases; AIS Electronic Library (AISeL), Science Direct, and Springer Link, complementing these with Google Scholar. After multiple revisions, the term searched within the title, keywords, or abstract was ("Technostress" OR "Technostress" OR "Techno-overload" OR "Techno-invasion" OR "Techno-complexity" OR "Techno-distress" OR "Digital stress" OR "E-stress" Or "Techno-eustress" OR "Stressors") AND ("Students" OR "University students" OR "College students" OR "Young generation" OR "Student learning" OR "Academic performance"). The scope encompasses journal articles, conference papers, and book chapters, only articles in English were taken into account. The search was performed between March 19th and 26th. The articles were chosen based on the presence of terms in the keywords, title, or abstract and then were downloaded based on their titles. However, if an article had the desired keywords but had an ambiguous title that raised doubts about its relevance to the topic under investigation, the abstract was screened to determine whether it should be downloaded. In step 5, articles were eliminated if they were duplicates, written in non-English language, or due to the paywalls and access problems. In the quality appraisal step, two further criteria were defined to exclude the articles that use the keywords in different contexts or do not answer the research questions stated in Section 1. As visualized in Table 1, our final pool included 57 papers which were analyzed and discussed in the next section.

Table 1. Article selection following Okoli's guidelines

Database	Search	Extract Data	Appraise Quality	Included Papers
AISeL	4	1	0	3
Google Scholar	97	23	32	42
Science Direct	25	6	13	6
Springer	21	7	8	6
Total	147	35	52	57

4 Findings

The first article studying technostress among students we were able to identify dates back to 1992 [46]. Following a flat trend until 2017, the subject garnered significantly more interest from researchers from 2019 onwards (see Figure 2). The primary reason for this increased attention can be attributed to the widespread impact of the COVID-19 pandemic, which led to the mandatory shift of students towards online education. A significant portion of the studies during this period were conducted in Indonesia, China, Malaysia, India, and the USA.

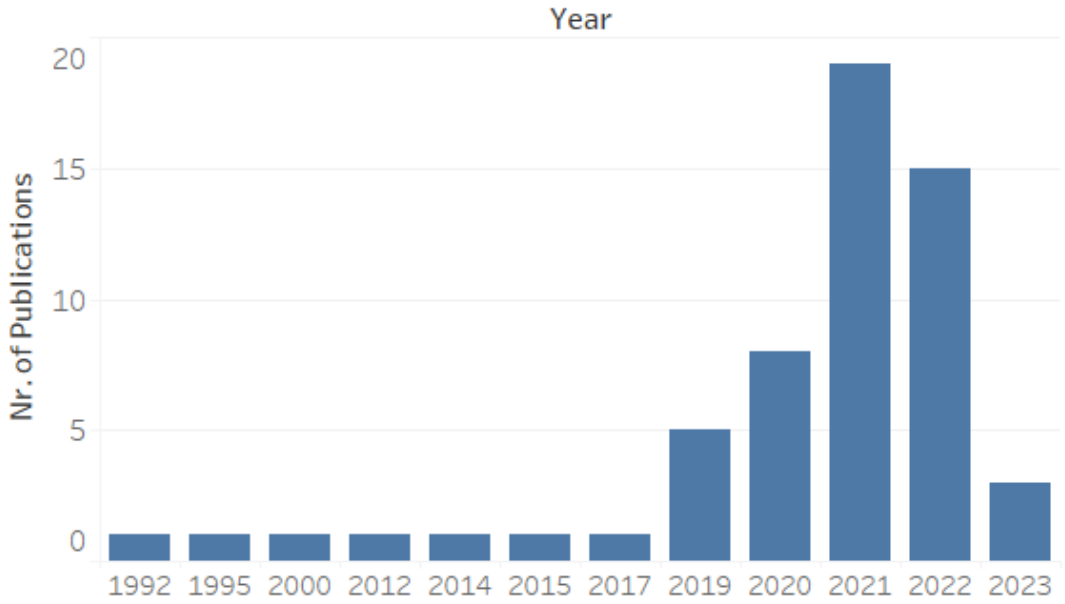

Fig. 2. Publications over the years

4.1 Potential consequences of technostress on students

The adoption of ICTs brings forth numerous advantages and disadvantages for individuals and organizations. In line with the duality aspect of technostress research [63], we classified the potential consequences of technostress on students from positive and negative aspects, as discussed in the next subsections.

Positive consequences Only a small subset of the articles included in our final pool mentioned positive consequences of technostress. [35] contend that the positive impact

of technostress manifests itself when distance learning prompts students to expand their abilities and acquire new skills, even in the face of mental exhaustion. They address this concept as "techno-challenge" and posit that challenging circumstances, despite demanding significant effort, can foster personal growth and accomplishment. Consequently, the stress experienced in this context is viewed as a motivating experience that stimulates the acquisition of essential skills for both individuals and their future professional endeavors. This view is supported in [24], where increase in productivity is mentioned as another positive outcome of technostress. The study also discusses that while technostress may result in heightened symptoms of anxiety and depression among students, perceived productivity can also evoke positive emotions such as a sense of accomplishment and success. This in turn may lead to increased commitment to the ongoing academic programs of the students [50].

Negative consequences Following [43], we classify the negative outcomes of technostress as psychological (cognitive and affective reactions) and behavioral (actions or intended responses) consequences. Regarding the psychological outcomes, [26] shows that technostress is associated with negative life experiences of the students on individual, group, and professional levels. On an individual level, the authors argue that repercussions of technostress can manifest itself in the form of technology addiction, or technology-related stress resulting from being overly immersed in technology. These outcomes can give rise to various consequences, including anxiety, beliefs of inefficiency, fatigue, and uncertainty in utilizing the technology. A study performed in [82] supports these findings, reporting that a student's technostress level is a significant predictor of his/her learning burnout.

As for the behavioral outcomes, [51] reports a decline in academic performance when students experience technostress, which can hinder their ability to concentrate on their academic tasks. As a consequence, their academic progress is disrupted, leading to a reduction in their overall performance as measured by factors such as WGPA and exam results. Similarly, [1] reports that technostress prevents students' capacity to effectively complete homework assignments and engage in studying. It can contribute to a lack of motivation, resulting in students becoming less proactive in fulfilling their academic responsibilities [67]. Moreover, [35] argues that the extensive use of mobile devices triggers technostress, which negatively influences their academic performance and productivity, leading to a loss of motivation and a higher risk of discontinuing pursuing academic goals [50].

4.2 Factors affecting the impact of technostress on students

In studies exploring technostress among students, researchers have examined the role of several variables affecting the impact of technostress. These variables encompass gender, age, and experience with ICT usage.

Gender The debate regarding the influence of gender on individuals' interaction with technology and their perception of technostress remains ongoing among researchers, with conflicting findings on this topic [82].

[67] argue that for teenage girls, extensive ICT use presents a complex issue both psychologically and socially, resulting in higher levels of computer anxiety compared to teenage boys. Quinn also highlights in her research that this difference can be attributed to cultural factors, as certain societies, traditionally associated computers with male dominance, resulting in women being socialized at school with the perception that computer use is not aligned with femininity [52].

Contrary to this perspective, there are additional findings indicating that women exhibit higher proficiency in technology utilization, while men are more susceptible to technostress and experience greater repercussions than females. As mentioned in [75], this could potentially be attributed to the fact that female students often demonstrate a more positive attitude towards learning compared to males and display greater adaptability to the changes brought about by the integration of technology in educational settings.

Several studies report no significant differences in technostress experienced by the two student groups. For example, [82] finds that both for male and female students, administration support in an academic context is negatively associated with technostress, and technostress is positively associated with learning burnout. Similarly, studying the Open and Distance Learning domain, [4] reports no significant gender differences in the manifestation of technostress among participants and [30] finds gender had no strong effect on technostress among the students.

Age Another factor impacting the experience of technostress is age, where technostress is found to be higher among younger people [53]. Regarding technostress among the students, our findings point out three different claims.

One group of researchers argues that technostress increases with age, as adult learners often feel inadequate, embarrassed, and even frustrated due to their limited computer skills, particularly when comparing themselves to their younger peers [52]. By categorizing the younger generation as digital natives and adults as digital immigrants [4], this group of researchers suggests that young individuals are characterized by energy, enthusiasm, flexibility, and a strong desire to learn new things. Young people are tech-savvy due to their early exposure to smartphones, computers, and other digital tools, which helps them establish computer literacy. On the other hand, older individuals often exhibit rigidity and a more traditional mindset, making it more challenging for them to adapt to and utilize technology compared to their younger counterparts [50].

In contrast, another group of researchers suggests that technostress decreases with age. This group argues that older students tend to be more motivated to learn and exhibit greater maturity compared to their younger peers. The aging process is associated with developing practical coping skills, which in turn help mitigate the negative consequences of technostress [24]. The final group represents the studies that indicate no substantial difference in age among students in their understanding of technostress [51, 57, 77].

ICT usage experience Research indicates that individuals who lack competence in ICTs and have lower computer self-efficacy are more likely to experience anxiety and frustration when using technology [53, 54, 59], which is also valid in the context of the students [82]. Students who are more familiar and comfortable with technology are better equipped to handle technostress and its associated challenges [56], when a student possesses a high level of digital literacy, the stress caused by technology is mitigated [2]. Regarding the ICT usage experience or self-efficacy, there seems to be a consensus considering that we identified a single study in our pool claiming no significant correlation between the experience of ICT use and the level of technostress perceived by students [38]. Nevertheless, the authors offer no potential reasons, nor do they discuss why this finding is in contrast with the literature.

4.3 Measuring technostress among the students and measurement methods

Quantitative methods are the predominant approach to investigating technostress among students, accounting for 89.5% (51/57) of the studies reviewed. Notably, all quantitative

studies employed cross-sectional designs, except for one experimental study[42]. Five studies adopted a conceptual approach, one study used mixed methods, and only one study relied solely on qualitative methods. Among the 51 papers adopting a quantitative approach, Tarafdar et al.'s instrument was used in 28 out of 51 papers (54.9%). A recent meta-analysis shows that technostress creators have been studied both as an aggregate (as a second-order construct) and disaggregate (with five first-order constructs, cf. Section 2.1) measure [43]. Following this, we investigated the articles in our final pool to understand the most significant technostress creators among the students. Of the 28 articles, 1 study does not indicate which first-order constructs were used. From the remainder, techno-overload was utilized in all studies (27 times), followed by techno-complexity (26 times), techno-invasion (22 times), techno-uncertainty and techno-insecurity (16 times each).

45.1% of articles (23/51) incorporate various instruments to investigate technostress among the students. One prevailing measurement scale here stems from the studies of Xinghua Wang which were referred to 6 times (26%). One relevant scale in this context is the Person-Environment (P-E) fit of technostress for university students [76], which includes 8 items with two first-order constructs, Abilities-demands misfit (ADT) and Needs-supplies misfit (NST). In a different study, the authors operationalize the same construct with three different components, namely Person-Organization (P–O) misfit of technostress, Person-Technology-enchanced-Learning (P-TEL) misfit of technostress, and Person-People (P–P) misfit of technostress [77].

4.4 Coping with technostress

Techno-stress is an inevitable aspect of modern life, and it is crucial to effectively manage it to prevent any negative impact on one's performance. The examination of the selected papers shows that the coping mechanisms proposed by the researchers can be categorized into five main dimensions.

One such dimension relates to enhancing personal capabilities, which involves engaging in activities such as attending specialized training programs [10], practicing mindfulness [78], pre-reading course materials [2], cultivating self-control [78], and implementing gamification techniques [22, 34]. These measures aim to develop and strengthen students' skills and competencies to effectively navigate and manage technostress. The second dimension is distancing from ICT environments. This can be achieved through various means, including engaging in physical activities like walking or participating in sports, exploring new hobbies such as cooking [25], prioritizing quality time with family and friends [6], intentionally disconnecting from technology for a few hours [34], and engaging in relaxation techniques [62]. These actions provide a much-needed break from the constant exposure to technology and help individuals find balance in their lives. One further dimension is modifying the settings of the used device which entails making specific adjustments to optimize the digital environment and minimize distractions. Examples of such modifications include minimizing unnecessary online social network usage, adjusting visibility settings to limit interruptions and notifications[81], utilizing alternative educational technologies that are less prone to distractions compared to smartphones, and implementing rules or guidelines within study groups to discourage posting unrelated chats or unnecessary content [6]. These actions help create a more focused and conducive digital environment for academic tasks and reduce the potential sources of stress associated with excessive technology use. Further, the students can utilize support mechanisms. This involves seeking assistance and guidance from various sources to alleviate the negative impact of technology-related stress. Examples of support mechanisms include consulting with a coach or mentor who can provide expert guidance and support [39] and seeking assistance from peers who can

offer social support and share experiences [70]. Last but not least, some scholars recommend students modify the social environment or adjust the physical conditions of the used device. This entails making changes to the immediate surroundings and ensuring optimal conditions for comfortable and efficient usage. Examples of such modifications include creating a suitable physical environment for studying [19], ensuring the availability of necessary tools such as a laptop or computer with a reliable internet connection [28], and utilizing devices that promote good posture, reducing the risk of health-related issues [4].

5 Discussion and Limitations

The objective of this study was to conduct a systematic review of articles addressing technostress among students to offer a comprehensive and dependable resource for students, technostress researchers, as well as practitioners in the education sector. For this, we followed Okoli's 8-step procedure, together with the carefully designed research protocols. After the definition of the inclusion and exclusion criteria, data were extracted from 57 papers for further analysis.

Most of the publications discuss the negative impacts of technostress on students, mentioning psychological (e.g. anxiety, fatigue, technology addiction, and burnout) as well as behavioral outcomes (e.g. decline in academic performance, lower task concentration, lower productivity). However, the positive consequences of technostress were only discussed in three papers (see also further below). [18, 50] argue that the primary reason for this contradiction might be the subjective nature of stress perception. Specifically, the negative effects of technology as a stressor on students only manifest when individuals perceive it as unrewarding. Conversely, if individuals view technology as useful, they become more tolerant towards it, and with that, the level of stress decreases [18].

We have investigated the differences in perceiving technostress among the students in terms of gender, age, and experience with ICT. We found conflicting evidence that gender and age had a negative, positive, and no significant impact on technostress. Noting the lack of cultural factors in technostress research among the students, the contrasting findings should offer an avenue for further research (see further below). Further variables can act as moderators in understanding the role of age and gender, such as the education level [20, 46] or academic motivation [68]. As for the ICT usage experience, research indicates that digital literacy plays a crucial role in understanding and managing technostress. Essel et al. suggest students with extensive ICT experience heavily rely on technologies that enhance their learning process [20]. We thus recommend that universities offer courses in their curricula that deliver digital literacy skills to the students.

Implementing effective coping strategies that align with the specific stressful situation can significantly mitigate the level of techno-stress experienced by students. However, it is important to acknowledge that stress management is contingent upon the individual's perception and interpretation of the stressful experience [22]. It is thus crucial to educate students about the advantages of different coping mechanisms and strategies, enabling them to select the most suitable method for effectively alleviating stress induced by technostress[25]. In this sense, teachers and education institutions also have a responsibility in designing coping mechanisms. Academics can encourage students to utilize and explore information and communication technologies [12], raising awareness among students about the impacts of information overload [5], considering individual learning styles, and providing lecture slides with accompanying audio notes before class [2]. Education centers can enhance the quality of programs utilized within to align with the student's proficiency levels. This includes measures such as employing user-friendly hardware and software and

offering comprehensive training for both teachers and students [4], providing clear instructions on the usage of diverse platforms or programs employed in the educational process [2], and developing user-friendly platforms with streamlined functionality to ensure ease of use [5]. Furthermore, they can implement well-structured academic planning and scheduling to ensure students have ample time for their academic responsibilities while maintaining a balanced and healthy lifestyle [67].

The study is subject to several limitations. First, the subject explored in this thesis is confined to technostress and its impact on students. While the inclusion of related groups in the education sector, such as teachers, academics, researchers, librarians, or administrators might have imposed different implications, the primary emphasis of this paper is on students. Second, although the search protocol was documented meticulously, and the principal investigator was trained on the SLR procedures, the inter-rater reliability was not assessed, which might be a cause of bias in the inclusion/ exclusion of the papers. Third, we did not include reports, working documents, theses, or policy documents in our analysis, which might be another source of bias, also limiting the generalizability of our findings. Finally, yet importantly, potential causes of variations in people's perceptions of different situations were not studied, which can contribute to diverse experiences of stress among them. Although it may not be possible to arrive at a definitive conclusion, efforts in this study have been made to attain a general conclusion based on the aggregated findings of the majority of researchers to the greatest extent possible.

6 Summary and Outlook

Our study aims to offer a general picture of the research landscape, enabling practitioners and researchers to fully grasp the findings and benefit from the suggestions proposed. We identified a trend from 2017 onwards, with a peak of publications in 2021, which might be related to the shift towards online education during and after the COVID-19 pandemic. The insights and recommendations put forth in this paper serve as valuable references for future research endeavors in this area. Against this background, three main research gaps arise regarding technostress among the students. The first gap is related to the fact that only a small subset specifically addresses the positive effects of techno-stress (eustress). Consequently, the coping strategies identified in this paper may differ from those applicable to eustress. It is essential to acknowledge this limitation and recognize that further investigation is needed to understand the strategies specific to eustress to provide a more comprehensive understanding of techno-stress among students. Following this, the second gap concerns the adoption of coping mechanisms from an intercultural lens. In our sample, we did not encounter studies related to the coping strategies utilized by international students, particularly in situations where they are exposed to new technologies that are unfamiliar to them in their home country but are prevalent in the host country. Research shows that subjective norms [73] and personality traits affect perceived technostress levels [61]; hence, this might be an area worth further exploring, potentially offering an alternative explanation for the contrasting findings on the impact of age and gender. Tied to this, comparative case studies might examine the degree of technostress perceived by students in both developing and developed countries, as well as the differences in coping strategies. Another potential research avenue relates to the method pluralism in the investigation of technostress. As discussed in Section 4.3, the selected studies in our pool utilize quantitative methods, mostly in the form of cross-sectional studies. Depending on the situation and the environment of the students, ICT use can also be beneficial, leading to techno-eustress (see Section 4.1). Against this background, we argue that the utilization of qualitative

methods can help unfold the duality of this phenomenon more efficiently, contextualizing when and why technology use leads to negative/ positive outcomes. Moreover, we identified the application of two main scales (see Section 4.3) in the quantitative studies. To shed light on the beneficial aspects of ICT use, further measurement instruments focusing on challenge/ hindrance technostressors (e.g. [58]) or positive well-being experiences regarding technology at work (e.g. [41]) should be utilized.

References

1. Abbas, A., Eliyana, A., Ekowati, D., Saud, M., Raza, A., Wardani, M.R.: Data set on coping strategies in the digital age: The role of psychological well-being and social capital among university students in java timor, surabaya, indonesia. Data in Brief **30**, 105583 (2020). https://doi.org/10.1016/j.dib.2020.105583, `https://www.sciencedirect.com/science/article/pii/S2352340920304777`
2. Abd Aziz, N.N., Awang Kader, M.A.R., Ab Halim, R.: The impact of technostress on student satisfaction and performance expectancy. Asian Journal of University Education **17**(4), 538 (2021). https://doi.org/10.24191/ajue.v17i4.16466
3. Agarwal, S., Kaushik, J.S.: Student's perception of online learning during covid pandemic. The Indian Journal of Pediatrics **87**(7), 554 (2020). https://doi.org/10.1007/s12098-020-03327-7, `https://link.springer.com/article/10.1007/s12098-020-03327-7`
4. Agbu, J.F.: Assessing technostress among open and distance learning practitioners: A comparative study. Asean Journal of Open and Distance Learning **7**(1), 43–56 (2015)
5. Al Abdullateef, H., Pasley, R., Chesney, T.: Exploring the effect of using whatsapp for education during covid-19 on university students' performance: A technostress perspective. In: UK Academy for Information Systems Conference Proceedings. vol. 11 (2021)
6. Al-Abdullatif, A.M., Alsubaie, M.A., Aldoughan, E.A.: Exploring the effects of excessive texting through mobile applications on students' technostress and academic writing skills in the arabic language. IEEE Access **8**, 166940–166950 (2020). https://doi.org/10.1109/ACCESS.2020.3024021
7. Al-Fudail, M., Mellar, H.: Investigating teacher stress when using technology. Computers & Education **51**(3), 1103–1110 (2008). https://doi.org/10.1016/j.compedu.2007.11.004
8. Ansar Abbasa, M. Saudb, Dian Ekowatic, Indrianawati Usmand, Shinta, Setiae: Technology and stress: A proposed framework for coping with stress in indonesian higher education. International Journal of Innovation, Creativity and Change **13**(4), 373–390 (2020)
9. Bakker, A.B., Demerouti, E., Sanz-Vergel, A.: Job demands–resources theory: Ten years later. Annual Review of Organizational Psychology and Organizational Behavior **10**(1), 25–53 (2023). https://doi.org/10.1146/annurev-orgpsych-120920-053933
10. Bencsik, A., Csinger, B.: The effects of technostress on higher education from the perspective of university students and lecturers – comparative analysis by age groups. In: Proceedings of the 14th International Scientific Conference RELIK (2021)
11. Bohnert, M., Gracia, P.: Emerging digital generations? impacts of child digital use on mental and socioemotional well-being across two cohorts in ireland, 2007–2018. Child Indicators Research **14**(2), 629–659 (2021). https://doi.org/10.1007/s12187-020-09767-z
12. Booker, Q.E., Rebman, C.M., Kitchens, F.L.: A model for testing technostress in the online education environment: An exploratory study. Issues in Information Systems **15**(II), 214–222 (2014)
13. Brod, C.: Managing technostress: optimizing the use of computer technology. The Personnel journal **61**(10), 753–757 (1982)
14. Brush, T., Glazewski, K.D., Hew, K.F.: Development of an instrument to measure preservice teachers' technology skills, technology beliefs, and technology barriers. Computers in the Schools **25**(1-2), 112–125 (2008). https://doi.org/10.1080/07380560802157972
15. Chai, C.S., Hong, H.Y., Teo, T.: Singaporean and taiwanese pre-service teachers' beliefs and their attitude towards ict use: A comparative study. The Asia-Pacific Education Researcher **18**(1) (2009). https://doi.org/10.3860/taper.v18i1.1040
16. Cho, S., Kim, S., Chin, S.W., Ahmad, U.: Daily effects of continuous ict demands on work-family conflict: Negative spillover and role conflict. Stress and health : journal of the International Society for the Investigation of Stress **36**(4), 533–545 (2020). https://doi.org/10.1002/smi.2955
17. Çoklar, A.N., Şahin, Y.L.: Technostress levels of social network users based on icts in turkey. European Journal of Social Sciences **23**(2), 171–182 (2011), `https://earsiv.anadolu.edu.tr/xmlui/handle/11421/14697`

18. Connolly, A.J., Rush, D.: How emotional self-control relates to it mindfulness and technostress in students. In: 25th Americas Conference on Information Systems, AMCIS 2019 Proceedings, (2019), https://scholarworks.boisestate.edu/cgi/viewcontent.cgi?article=1069&context=itscm_facpubs
19. Erdoğan, A., Öztürk, M., Erdoğan, P., Zor, R.K., Çınaroğlu, S., Öztorun, K., Kayabaş, Ü.: Technostress in medical students during pandemic-prompted distance education: Adaptation of technostress scale based on person-environment misfit theory. Turkish Online Journal of Educational Technology - TOJET **21**(3), 63–74 (2022), https://eric.ed.gov/?id=EJ1345975
20. Essel, H.B., Vlachopoulos, D., Tachie-Menson, A., Johnson, E.E., Ebeheakey, A.K.: Technology-induced stress, sociodemographic factors, and association with academic achievement and productivity in ghanaian higher education during the covid-19 pandemic. Information **12**(12), 497 (2021). https://doi.org/10.3390/info12120497
21. Estrada-Muñoz, C., Castillo, D., Vega-Muñoz, A., Boada-Grau, J.: Teacher technostress in the chilean school system. International journal of environmental research and public health **17**(15) (2020). https://doi.org/10.3390/ijerph17155280
22. Fajri, F.A., Haribowo P., R.K., Amalia, N., Natasari, D.: Gamification in e-learning: The mitigation role in technostress. International Journal of Evaluation and Research in Education (IJERE) **10**(2), 606 (2021). https://doi.org/10.11591/ijere.v10i2.21199
23. Fieseler, C., Grubenmann, S., Meckel, M., Müller, S.: The leadership dimension of coping with technostress. In: 2014 47th Hawaii International Conference on System Sciences. pp. 530–539 (2014). https://doi.org/10.1109/HICSS.2014.73
24. Galvin, J., Evans, M.S., Nelson, K., Richards, G., Mavritsaki, E., Giovazolias, T., Koutra, K., Mellor, B., Zurlo, M.C., Smith, A.P., Vallone, F.: Technostress, coping, and anxious and depressive symptomatology in university students during the covid-19 pandemic. Europe's Journal of Psychology **18**(3), 302–318 (2022). https://doi.org/10.5964/ejop.4725, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9632553/
25. Gildemyn, M., van Belle, J.P., Turpin, M.: Impact of technostress on belgian business management students. Gurugram University Business Review (GUBR) **2**(2), 10–18 (2022)
26. González-López, Ó.R., Buenadicha-Mateos, M., Sánchez-Hernández, M.I.: Overwhelmed by technostress? sensitive archetypes and effects in times of forced digitalization. International journal of environmental research and public health **18**(8) (2021). https://doi.org/10.3390/ijerph18084216
27. Haleem, A., Javaid, M., Qadri, M.A., Suman, R.: Understanding the role of digital technologies in education: A review. Sustainable Operations and Computers **3**, 275–285 (2022). https://doi.org/10.1016/j.susoc.2022.05.004, https://www.sciencedirect.com/science/article/pii/S2666412722000137
28. Harahap, K., Nasution, A., Purba, E., Zainal, A.: The effect of technostress on technology-based learning on academic productivity with job outcome students as intervening variables in accounting students. In: Setiawan (ed.) Proceedings of the International Joint Conference on Arts and Humanities 2022 (IJCAH 2022), Advances in Social Science, Education and Humanities Research, vol. 724, pp. 1292–1302. Atlantis Press, Paris (2023). https://doi.org/10.2991/978-2-38476-008-4_138
29. Higgins, K., Huscroft-D'Angelo, J., Crawford, L.: Effects of technology in mathematics on achievement, motivation, and attitude: A meta-analysis. Journal of Educational Computing Research **57**(2), 283–319 (2019). https://doi.org/10.1177/0735633117748416
30. Hsiao, K.L., Shu, Y., Huang, T.C.: Exploring the effect of compulsive social app usage on technostress and academic performance: Perspectives from personality traits. Telematics and Informatics **34**(2), 679–690 (2017). https://doi.org/10.1016/j.tele.2016.11.001, https://www.sciencedirect.com/science/article/pii/S073658531630209X
31. Jena, R.K.: Impact of technostress on job satisfaction: An empirical study among indian academician. The International Technology Management Review **5**(3), 117 (2015). https://doi.org/10.2991/itmr.2015.5.3.1
32. Joo, Y.J., Lim, K.Y., Kim, N.H.: The effects of secondary teachers' technostress on the intention to use technology in south korea. Computers & Education **95**, 114–122 (2016). https://doi.org/10.1016/j.compedu.2015.12.004, https://www.sciencedirect.com/science/article/pii/S0360131515300944
33. Jung, I., Kudo, M., Choi, S.K.: Stress in japanese learners engaged in online collaborative learning in english. British Journal of Educational Technology **43**(6), 1016–1029 (2012). https://doi.org/10.1111/j.1467-8535.2011.01271.x
34. Kekkonen, M., Oinas-Kukkonen, H.: Doctoral students' battle of stress - designing bcss to help them win the battle: Searching for design improvements via workshops with end-users. In: Piiastiina Tikka, Nataliya Shevchuk, Harri Oinas-Kukkonen (eds.) Proceedings of the Ninth International Workshop on Behavior Change Support Systems co-located with the 16th International Conference on Persuasive Technology 2021 (Persuasive 2021), Bournemouth, UK, April 12th, 2021. CEUR Workshop Proceedings, vol. 2885, pp. 47–64. CEUR-WS.org (2021), https://ceur-ws.org/Vol-2885/paper5.pdf

35. Kulikowski, K., Przytuła, S., Sułkowski, Ł., Rašticová, M.: Technostress of students during covid-19 - a sign of the time? Human Technology **18**(3), 234–249 (2022). https://doi.org/10.14254/1795-6889.2022.18-3.3, https://ht.csr-pub.eu/index.php/ht/article/view/305
36. Kupersmith, J.: Technostress and the reference librarian. Reference Services Review **20**(2), 7–50 (1992). https://doi.org/10.1108/eb049150
37. Lazarus, R.S., Folkman, S.: Transactional theory and research on emotions and coping. European Journal of Personality **1**(3), 141–169 (1987). https://doi.org/10.1002/per.2410010304
38. Lee, S.J., Jin, S.H., Choi, B.J.: The influence of technostress and antismart on continuous use of smartphones. In: Proceedings of the World Congress on Engineering and Computer Science (2012), https://api.semanticscholar.org/CorpusID:15254128
39. Li, X., Liu, D.: The influence of technostress on cyberslacking of college students in technology-enhanced learning: Mediating effects of deficient self-control and burnout. International journal of environmental research and public health **19**(18) (2022). https://doi.org/10.3390/ijerph191811800
40. Magday, E.R.J.: Technostress levels among science education students of central mindanao university. International Journal of Multidisciplinary Research and Publications (IJMRAP) **5**(6), 119–122 (2022)
41. Mäkiniemi, J.P., Ahola, S., Joensuu, J.: A novel construct to measure employees' technology-related experiences of well-being: Empirical validation of the techno-work engagement scale (technowes). 2002-2867 **5**(1) (2020). https://doi.org/10.16993/sjwop.79, https://sjwop.com/articles/10.16993/sjwop.79
42. Munir, A., Sugiyo, S., Mulawarman, M.: The effectiveness of group counseling with sfbc and mindfulness training group approaches to reduce the technostress of students who use smartphone. Jurnal Bimbingan Konseling **10**(1), 42–48 (2021)
43. Nastjuk, I., Trang, S., Grummeck-Braamt, J.V., Adam, M.T.P., Tarafdar, M.: Integrating and synthesising technostress research: A meta-analysis on technostress creators, outcomes, and is usage contexts. European Journal of Information Systems pp. 1–22 (2023). https://doi.org/10.1080/0960085X.2022.2154712
44. Norhisham, N.: Understanding technostress during the era of covid-19: A conceptual paper. International Journal of Academic Research in Business and Social Sciences **11**(8) (2021). https://doi.org/10.6007/IJARBSS/v11-i8/10628
45. Okoli, C.: A guide to conducting a standalone systematic literature review. Communications of the Association for Information Systems **37** (2015). https://doi.org/10.17705/1CAIS.03743
46. Omar, M.H.: Attitudes of college students towards computers: A comparative study in the united states and the middle east. Computers in Human Behavior **8**(2-3), 249–257 (1992). https://doi.org/10.1016/0747-5632(92)90009-4, https://www.sciencedirect.com/science/article/pii/0747563292900094
47. Özgür, H.: Relationships between teachers' technostress, technological pedagogical content knowledge (tpack), school support and demographic variables: A structural equation modeling. Computers in Human Behavior **112**, 106468 (2020). https://doi.org/10.1016/j.chb.2020.106468, https://www.sciencedirect.com/science/article/pii/S074756322030220X
48. Pamela S. Galluch, V. Grover, J. Thatcher: Interrupting the workplace: Examining stressors in an information technology context. J. Assoc. Inf. Syst. (2015), https://www.semanticscholar.org/paper/Interrupting-the-Workplace%3A-Examining-Stressors-in-Galluch-Grover/03dceca8c75742c79edb3b1e43fc871d1b83897f
49. Perera, D.R.: Does technostress impact on university students' academic performance in the new normal? International Journal of Engineering and Management Research **11**(6) (2021). https://doi.org/10.31033/ijemr.11.6.12
50. Pirzada, G., Farooq, F., Mahmood, A.: Impact of technostress on vocational education students during online learning in pakistan. Pakistan Journal of Social Research **04**(04), 55–64 (2022). https://doi.org/10.52567/pjsr.v4i04.787
51. Qi, C.: 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 (2019). https://doi.org/10.1080/0144929X.2019.1585476
52. Quinn, B.: Overcoming technostress in reference services to adult learners. The Reference Librarian **33**(69-70), 49–62 (2000). https://doi.org/10.1300/J120v33n69_05
53. Ragu-Nathan, T.S., Tarafdar, M., Ragu-Nathan, B.S., Tu, Q.: The consequences of technostress for end users in organizations: Conceptual development and empirical validation. Information Systems Research **19**(4), 417–433 (2008). https://doi.org/10.1287/isre.1070.0165
54. Salanova, M., Llorens, S., Cifre, E.: The dark side of technologies: technostress among users of information and communication technologies. International journal of psychology : Journal international de psychologie **48**(3), 422–436 (2013). https://doi.org/10.1080/00207594.2012.680460

55. Sami, L.K., Pangannaiah, N.B.: "technostress" a literature survey on the effect of information technology on library users. Library Review **55**(7), 429–439 (2006). https://doi.org/10.1108/00242530610682146
56. Sethi, D., Pereira, V., Arya, V.: Effect of technostress on academic productivity. Journal of Global Information Management **30**(5), 1–19 (2021). https://doi.org/10.4018/JGIM.290365
57. Shaik, K.: Technostress among students during covid-19 lockdown. Dogo Rangsang Research Journal **10**(09) (2020), https://www.journal-dogorangsang.in/no_3_sep_20/30.pdf
58. Shi, S., Chen, Y., Cheung, C.M.K.: How technostressors influence job and family satisfaction: Exploring the role of work–family conflict. Information Systems Journal **33**(4), 953–985 (2023). https://doi.org/10.1111/isj.12431, https://onlinelibrary.wiley.com/doi/full/10.1111/isj.12431
59. Shu, Q., Tu, Q., Wang, K.: The impact of computer self-efficacy and technology dependence on computer-related technostress: A social cognitive theory perspective. International Journal of Human-Computer Interaction **27**(10), 923–939 (2011). https://doi.org/10.1080/10447318.2011.555313
60. Sonnentag, S., Tay, L., Nesher Shoshan, H.: A review on health and well–being at work: More than stressors and strains. Personnel Psychology **76**(2), 473–510 (2023). https://doi.org/10.1111/peps.12572
61. Srivastava, S.C., Chandra, S., Shirish, A.: Technostress creators and job outcomes: theorising the moderating influence of personality traits. Information Systems Journal **25**(4), 355–401 (2015). https://doi.org/10.1111/isj.12067
62. Stoeckl, F., Eckhardt, A.: Sociability and technostress in online classes: The effects on students' emotional exhaustion during the covid-19 pandemic. In: Proceedings of the 56th Hawaii International Conference on System Sciences (2023)
63. Tarafdar, M., Cooper, C.L., Stich, J.F.: The technostress trifecta – techno eustress, techno distress and design: Theoretical directions and an agenda for research. Information Systems Journal **29**(1), 6–42 (2019). https://doi.org/10.1111/isj.12169
64. Tarafdar, M., Pirkkalainen, H., Salo, M., Makkonen, M.: Taking on the "dark side"—-coping with technostress. IT PROFESSIONAL **22**(6), 82–89 (2020). https://doi.org/10.1109/MITP.2020.2977343, https://researchportal.tuni.fi/en/publications/taking-on-the-dark-sidecoping-with-technostress
65. Tarafdar, M., Pullins, E.B., Ragu-Nathan, T.S.: Technostress: negative effect on performance and possible mitigations. Information Systems Journal **25**(2), 103–132 (2015). https://doi.org/10.1111/isj.12042
66. Tarafdar, M., Tu, Q., Ragu-Nathan, B.S., Ragu-Nathan, T.S.: The impact of technostress on role stress and productivity. Journal of Management Information Systems **24**(1), 301–328 (2007). https://doi.org/10.2753/MIS0742-1222240109
67. Upadhyaya, P., Vrinda: Impact of technostress on academic productivity of university students. Education and Information Technologies **26**(2), 1647–1664 (2021). https://doi.org/10.1007/s10639-020-10319-9
68. Vallone, F., Galvin, J., Della Cattaneo Volta, M.F., Akhtar, A., Chua, S., Ghio, E., Giovazolias, T., Kazakou, Z., Kritikou, M., Koutra, K., Kovacevic, S., Lee-Treweek, G., Mašková, I., Mavritsaki, E., Nastic, J., Plassova, M., Stuchlíková, I., Zurlo, M.C.: Technostress and academic motivation: direct and indirect effects on university students' psychological health. Frontiers in Psychology **14**, 1211134 (2023). https://doi.org/10.3389/fpsyg.2023.1211134, https://www.frontiersin.org/articles/10.3389/fpsyg.2023.1211134/full
69. Valverde-Berrocoso, J., Acevedo-Borrega, J., Cerezo-Pizarro, M.: Educational technology and student performance: A systematic review. Frontiers in Education **7** (2022). https://doi.org/10.3389/feduc.2022.916502
70. Vega-Muñoz, A., Estrada-Muñoz, C., Andreucci-Annunziata, P., Contreras-Barraza, N., Bilbao-Cotal, H.: Validation of a measurement scale on technostress for university students in chile. International journal of environmental research and public health **19**(21) (2022). https://doi.org/10.3390/ijerph192114493
71. Verkijika, S.F.: Digital textbooks are useful but not everyone wants them: The role of technostress. Computers & Education **140**, 103591 (2019). https://doi.org/10.1016/j.compedu.2019.05.017, https://www.sciencedirect.com/science/article/pii/S0360131519301320
72. Wang, K., Shu, Q., Tu, Q.: Technostress under different organizational environments: An empirical investigation. Computers in Human Behavior **24**(6), 3002–3013 (2008). https://doi.org/10.1016/j.chb.2008.05.007, https://www.sciencedirect.com/science/article/pii/S0747563208001040
73. Wang, Q., Zhao, G., Cheng, Z.: Examining the moderating role of technostress and compatibility in efl learners' mobile learning adoption: A perspective from the theory of planned behaviour. Frontiers in Psychology **13**, 919971 (2022). https://doi.org/10.3389/fpsyg.2022.919971, https://www.frontiersin.org/articles/10.3389/fpsyg.2022.919971/full

74. Wang, X., Li, B.: Technostress among university teachers in higher education: A study using multidimensional person-environment misfit theory. Frontiers in psychology **10**, 1791 (2019). https://doi.org/10.3389/fpsyg.2019.01791
75. Wang, X., Li, Z., Ouyang, Z., Xu, Y.: The achilles heel of technology: How does technostress affect university students' wellbeing and technology-enhanced learning. International journal of environmental research and public health **18**(23) (2021). https://doi.org/10.3390/ijerph182312322
76. Wang, X., Tan, S.C., Li, L.: Measuring university students' technostress in technology-enhanced learning: Scale development and validation. Australasian Journal of Educational Technology (AJET) pp. 96–112 (2020). https://doi.org/10.14742/ajet.5329
77. Wang, X., Tan, S.C., Li, L.: Technostress in university students' technology-enhanced learning: An investigation from multidimensional person-environment misfit. Computers in Human Behavior **105**, 106208 (2020). https://doi.org/10.1016/j.chb.2019.106208, https://www.sciencedirect.com/science/article/pii/S0747563219304285
78. Whelan, E., Golden, W., Tarafdar, M.: How technostress and self-control of social networking sites affect academic achievement and wellbeing. Internet Research **32**(7), 280–306 (2022). https://doi.org/10.1108/INTR-06-2021-0394, https://www.emerald.com/insight/content/doi/10.1108/INTR-06-2021-0394/full/pdf
79. Yao, N., Wang, Q.: Technostress from smartphone use and its impact on university students' sleep quality and academic performance. The Asia-Pacific Education Researcher **32**(3), 317–326 (2023). https://doi.org/10.1007/s40299-022-00654-5
80. Yener, S., Arslan, A., Kilinç, S.: The moderating roles of technological self-efficacy and time management in the technostress and employee performance relationship through burnout. Information Technology & People **34**(7), 1890–1919 (2021). https://doi.org/10.1108/ITP-09-2019-0462
81. Yu, L., Shi, C., Cao, X.: Understanding the effect of social media overload on academic performance: A stressor-strain-outcome perspectiv. In: Proceedings of the 52nd Hawaii International Conference on System Sciences (2019)
82. Zhao, G., Wang, Q., Wu, L., Dong, Y.: Exploring the structural relationship between university support, students' technostress, and burnout in technology-enhanced learning. The Asia-Pacific Education Researcher **31**(4), 463–473 (2022). https://doi.org/10.1007/s40299-021-00588-4

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