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Impact of technostress on academic productivity of university students

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Abstract
There has been increasing interest among researchers to understand the negative effects of technology, in the last two decades. Technostress or stress induced due to technology is extensively reported in the literature, among working professionals. Even though there has been an increased proliferation of digital devices in academia, there is a dearth of studies examining the prevalence of technostress and its impact among students. This study examines the prevalence of technostress among the younger population, in the age group of 18–28 years. Using a sample of 673 Indian private university students, this study cross-validated the technostress instrument. Increased use of technology in higher education has compelled students to complete all their academic work, including assessments, using technology. Technology-enhanced learning applications such as learning management systems, MOOCs and digital exam devices require students to develop ICT skills. The study also investigates the impact of technostress on the academic productivity of students. Findings reveal that the technostress instrument is valid to be used in the academic context, with minor modifications, and students experienced moderate levels of technostress. It was also found that technostress had a negative impact on the academic productivity of students.

Keywords Technostress · Academic productivity · Higher education · Students

1 Introduction

Developments in ICT and its ubiquity has accelerated the use of ICT among higher education institutions (HEIs). Technology is being extensively used for

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automating academic processes and enhance the teaching and learning process. The use of Technology Enhanced Learning (TEL) has risen exponentially in academia, due to government incentives and to meet students' anticipations (Dunn & Kennedy, 2019). Technology is being used for academic administration and student self-service, through applications such as student's life cycle management (Wang et al., 2018), learning management systems, MOOCs, integrated digital-based assessment (Barana et al., 2016) and attendance management system (Ofelia et al., 2017). Online learning and MOOCs were found to reduce the higher education costs for students (Deming et al., 2015) and students were found to have a positive perception towards integrating ICT in the classroom (Vahedi et al., 2019). For HEIs, ICT is found to aid in reducing distance barriers (Agarwal & Mittal, 2018) and reduce paperwork (Pattinson, 2017). Besides, ICT enables HEIs to streamline academic administration, bring transparency, and speed up the academic data processing. Integrating technology in the classroom is believed to improve the teaching and learning process (Mirzajani et al., 2016).

While the benefits of technology cannot be argued, there has been increased interest in understanding the negative impact of technology on end-users. Technostress or "inability to cope with new technologies", have been extensively studied in the literature on the organization employees and its impact on job outcomes (Tarafdar et al., 2007, 2011b, Tarafdar et al., 2019; Torre et al., 2019). A recent review has reported the negative influence of technostress on employee's six psychological and behavioral outcomes, one of them being employee productivity (Sarabadani et al., 2018). Studies in technostress have focused on various groups like employees (Tarafdar et al., 2007, 2011a, b; Hauk et al., 2019) knowledge workers (Chen, 2015) and employees in their early retirement/older adults (Nimrod, 2017). A case study by Davies (2015) found that first-year psychology undergraduate students experienced test anxiety, computer anxiety, and technostress, during their first Online MCQ Assessment. On the contrary, Qi (2019), found that the use of mobile devices for academic purposes had no impact on technostress.

There is a dearth of empirical studies that have examined the prevalence of technostress among the younger generation, in particular, students. Technostress among students may lead to a higher burden on the higher education institutions through a decrease in productivity, dropouts, and deviation from academic work. Therefore, there is a need to examine the prevalence of technostress among students and its consequences. Students of the present generation have a different set of characteristics and habits, which makes them an interesting group to be studied. By 2020, new generation cohort steps into the business world and are called as Digital Natives (Rothman, 2016). These students are born in the Internet-connected world and ICT is part of their routine (Desai & Lele, 2017). Digital Natives are habituated to immediate and autonomous access to information, multitasking, nonlinear learning, and dynamic graphics (Brooks & Davis, 2018). Therefore, it would be interesting to test whether the technostress is relevant to this generation, its prevalence among various demographics of students, and its impact on academic productivity.

In this backdrop, we use the technostress scale proposed by Tarafdar et al. (2007) and validate the instrument in an academic context and measure the technostress levels among the undergraduate and postgraduate students, in a private university. The relationship between technostress and academic productivity is also examined. The research aims to address the following research questions:

- What is the validity of the technostress instrument on the student population?
- Is there any difference in technostress in students, based on gender, age, level of education, and experience with ICT?
- To what extent does the technostress impact the academic productivity of students?

2 Literature review

Drawing primarily from the transactional model, stress has been defined as "an individual psychological response to a situation, where the situation demands exceed the individual and situational capacity/resources or ability to cope with the situation" (Folkman & Lazarus, 1980; Lazarus & Folkman, 1984). Using sociotechnical and role theory, Tarafdar et al. (2007) explained that these stressors are the conditions (creators) that originate from social or role (role stressor) and technical or task (task stressor) or the use of ICTs (technology stressor).

Past research studies posit ICT as one of the causes of stress. The term 'Technostress' was first introduced by Brod (1984) and defined as "a modern disease of adaptation caused by an inability to cope with the new computer world technologies in an unhealthy manner". Clark and Kalin (1996) described that "technostress is not a disease, and is a negative psychological, behavioral and physiological impact caused, either directly or indirectly, by technology". Technostress creators are conceptualized as "job demands which require high physical, social, and cognitive skills, with an associated psychological cost" (Mahapatra & Pati, 2018).

Technostress is referred by different terminologies such as technophobia and computer anxiety (Hung et al., 2011; Laspinas, 2015). Tarafdar et al. (2007) defined technostress as a "problem of adaptation that individual experiences, when he or she is unable to cope with new technology." and proposed a multi-dimensional scale with five components techno-overload, techno-invasion, techno-complexity, techno-insecurity, and techno-uncertainty.

3 Technostress: A double-edged sword

Researchers and practitioners have proposed technostress as 'a double-edged sword' (Qi, 2019), by considering both the positive and negative impact of technostress for individuals and their organizations. Tarafdar et al. (2019) proposed a revised framework of Technostress as a trifecta by considering techno-eustress, techno-distress, and information systems design. The framework incorporates both positive and negative outcomes of technostress, along with mitigating negative effects through appropriate IS design. The framework defines techno-eustress as the process in which an individual elucidate IS as challenging or thrilling, and the individual experiences good stress and results in positive outcomes. Techno-distress is defined as the process where an individual evaluates IS as a threat, experience "bad" stress, and encounters unfavorable outcomes.

Schlachter et al. (2018) demonstrated that the use of ICT enables the task to be more portable and remotely accessible, leading to an increase in employees' performance, improved job satisfaction, and work-family balance. Ayyagari et al. (2011) found continuous connectivity with ICT enhances the work speed and thereby increases the productivity and quality of an individual life.

On the contrary, Wang et al. (2008) found that the employees from centralized and innovative organizations, often showcase peak level of technostress. The dark side of technology usage referred to as 'technostress' (Tarafdar et al., 2011a, b) has been extensively researched in the past, examining its impact on organizational behavior and psychological stress (Tarafdar et al., 2019). Technostress has been found to impact negatively on organizational behavior such as employee productivity (Hung et al., 2015), performance (Tarafdar et al., 2014), end-user satisfaction (Fuglseth & Sorebo, 2014), job satisfaction (Kumar et al., 2013) and continuance commitment (Raghu-Nathan et al., 2008). Few studies also manifested the impact of technostress on psychological behavioral outcomes of an employee such as strain (Raghu-Nathan et al., 2008) or the extent to which the individual feels tired (Ayyagari et al., 2011). Researchers have reported several other behavioral outcomes of technostress such as burnout (Mahapatra & Pati, 2018) and also physical health implications such as repetitive eyestrain, headaches, blood pressure, backaches, stomach problems, irritability and heart attacks (Tams et al., 2013). In an academic context, Samaha and Hawi (2016) found that there is a significant impact of mobile technology addiction on students' academic performance and satisfaction with life.

3.1 Technology and digital natives

The present generation students are often referred to as 'digital natives'. They possess technological fluency that is inherent ability to familiarize themselves with new technology demands, with greater ease (Prensky, 2001). Further, Prensky (2007) also quoted "students (digital natives) are insisting for these [new] technologies to be used as part of their education, in part because they are things that the students have already mastered and use in their daily lives, and in part, because they understand just how useful they can be". It is believed that current generation learners have well developed productive learning habits, multitasking, teamwork, but on the other side, digital natives are incapable of deep learning and productive work. Digital natives are believed to have sufficient ICT skills and adapt to changes (Joo et al., 2016).

Studies on these digital natives have reported positive effects of ICTs on academic performance. Qi (2019) found the use of mobile devices had a positive impact on students' academic performance. Morris and Morris (2010) found that technology-driven assessment in classroom boosts the academic performance among students. Insua et al. (2016) argued that, students are using ICT for their personal use, entertainment, and leisure time rather than academic use and found that higher use of ICT leads to better academic performance. Rabiu (2016) posited that the frequency of mobile phone usage does not considerably influence academic performance among undergraduate students. On the contrary, a study conducted by Jena (2015) among Indian University students found that, TEL results in burnout, reduced engagement in learning, poor academic performance, and intention to drop out.

Tarafdar et al. (2019) in the trifecta model noted the significance of studying the demographical data due to the individual difference in handling the technology with confidence. Hence, we examine the association of students' demographic factors and level of technostress.

3.2 Technostress and gender

Several studies (Broos, 2005; Qi, 2019), has noted male students have a lower level of technostress as compared to females and they are involved with innovation performance using technology (Chandra et al., 2019). For female adolescents' frequency of internet and technology use is both psychologically and socially a complex affaire (Broos & Roe, 2006) and experience more computer anxiety than male adolescents (Tekinarslan, 2008). There are also contradictory results observed that male employees experienced more technostress than female counterparts (Ragu-Nathan et al., 2008; Tarafdar et al., 2014). Based on the literature, we propose that

H1: There is a difference in technostress levels of male and female students

3.3 Technostress and age

A recent longitudinal study by Hauk et al. (2019) propose that age is positively associated with the level of technostress using cognitive theories on aging, where an individual experience deterioration of his/her motor skill over the age (Reuter et al., 2012). A meta-analysis by Hauk et al. (2018) posited that older adults find higher difficulties in using technology compared to younger adults, specifically with techno-overload and techno-complexity, which require a complex amount of cognitive abilities and physical condition. However, Ragu-Nathan et al. (2008) found that the technostress decreases as age increases. Most of the research studies are on the working population and their associated age ranges, with only a few studies focusing on students (Shu et al., 2011; Wang et al., 2008). Therefore, previous findings on age effects are contradictory. In the present study, we propose to examine the following hypothesis for the students grouped into two age groups (18–22 and 23–28 years)

H2: There is a difference in technostress levels of students with different age groups

3.4 Technostress and level of education

The literature on technostress in education is relatively limited. Rather, Ragu-Nathan et al. (2008) and Wang et al. (2008) found that the level of education inversely influences technostress. With the experience in computer learning, formally educated students experience less technostress (Tarafdar et al., 2011b). However, one study reported that education level has no significant relationship with technostress (Shu et al., 2011). With this mixed result, current research proposes below hypothesis:

H3: There is a difference in technostress levels of undergraduate and postgraduate students.

3.5 Technostress and level of ICT experience

The ICT experience is referred to as "*number of years of experience, with the use of technology*". Zhao et al. (2020) confirmed a positive association of ICT experience with productivity and inverse association with technostress. Qi, (2019) found that there is no significant association of technostress with the level of ICT experience. Ragu-Nathan et al. (2008) found that managers with higher confidence in their ability to use ICTs experience less technostress. Higher levels of technostress are associated with less experience using technology (Shu et al., 2011). Therefore, we propose the following

H4: There is a difference in technostress levels of students with respect to their level of ICT experience.

3.6 Technostress and productivity

In Information systems discipline, productivity is often referred to as 'task productivity' and defined as "the extent that an application improves the user's output per unit of time" (Torkzadeh & Doll, 1999). Hysenbegasi et al. (2005) measured academic productivity using students' grade point average(GPA).

Tarafdar et al. (2007) conceptualized productivity as "increased work efficiency and output during work hours through mobile technologies as perceived by staff members". Tarafdar et al. (2007) found a negative impact of five technostress creators on productivity at the workplace. Lee et al. (2016) validated the inverse association of technostress from mobile communication on quality of life and employee productivity. Hung et al. (2011) found that 'ubiquitous technostress' or stress caused by the overuse of mobile phones at the workplace has a negative effect on employees' productivity. Based on the previous literature, the research model is presented in Fig. 1 and we propose that

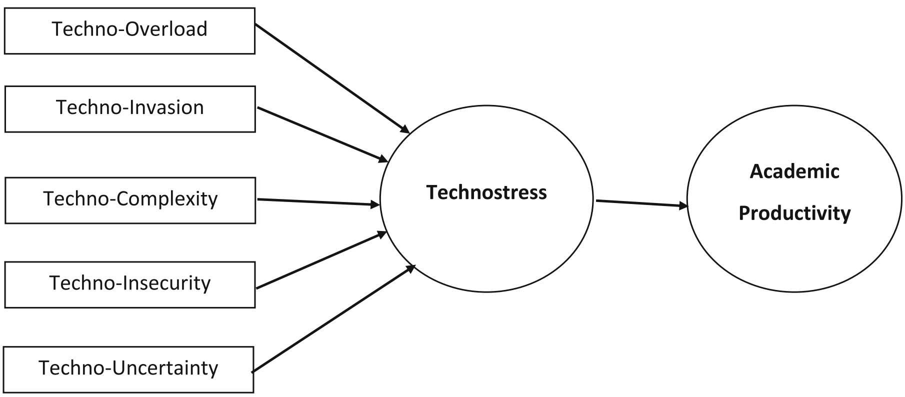

Fig. 1 Research model

H5: Technostress has a negative effect on students' academic productivity.

4 Research method

The study was conducted in a multidisciplinary, private university in Southern India. The university uses ICT to automate the administration of academic data through the Student Lifecycle Management system. The university also conducts assessments through the digital exam pad systems. Technostress among students was measured using a 23 item scale proposed by Tarafdar et al. (2007). All the items were measured in five-point likert scale. Technostress was modeled as a second-order construct, with five sub-dimensions namely techno-overload, techno-invasion, techno-complexity, techno-insecurity, and techno-uncertainty. Techno-overload is defined as the effect of technology that forces students to work faster and longer. Techno-invasion is defined as the effect of technology that forces students to work beyond regular college hours and invades their personal lives. Techno-complexity is defined as a situation where technology makes students feel that their skill sets are inadequate. In the context of higher education, Techno-insecurity is defined as the situation where the students feel threatened about poor academic performance compared to other students, who have a better knowledge of using technology. Techno-uncertainty refers to a situation where frequent changes and upgrades in technology, create uncertainty for students. The sub-constructs techno-complexity, techno-insecurity and techno-uncertainty were modified and adapted to suit academic context.

Academic productivity was measured as a four-item scale adapted from previous works of Torkzadeh and Doll (1999) and Tarafdar et al. (2007). However, in this study, the scale was modified to the academic context. The changes done to the original instrument is elaborated in a separate section in the Appendix 2.

The research questionnaire was mailed to 2300 undergraduate and postgraduate students. Six hundred seventy two completed responses were received, after one follow up, with a response rate of 29%. The respondents in the sample belonged to the age group of 18–28 years, with 80% of the students falling in the 18–22 age group. The median age of the sample is 20. Among the respondents, 55% of students were male and 45% were female. Fifty-three percent of the students were undergraduates and the remaining were postgraduates. The students reported an average of 10 years of experience in using ICT.

5 Analysis, results, and discussion

5.1 Technostress scale validation and reliability

The initial review of data revealed the absence of any missing data in the responses received. A confirmatory factor analysis was run to ascertain the structure of the sub-constructs of technostress and ensure construct validity. The factor analysis with the principal component method and varimax rotation was used (Ho, 2006). The results indicated an acceptable value of Keiser-Meyer-Olkin Measure of Sampling Adequacy (KMO-SA) of 0.886. As per Malhotra (1999), values of KMO-MSA greater than 0.5

would indicate the validity of the factor analysis. The output of the factor loadings of all the 23 items in the instrument in the rotated component matrix was observed and items with factor loadings of less than 0.5 were removed from further analysis. The factor loadings of all the items in the rotated component matrix are shown in Table 1.

It was observed that one item in Techno-overload (TO5) and three items, namely TIS1, TIS2, TIS3 of Techno-insecurity had a factor loading of less than 0.5, therefore it was dropped from further analysis. As the scale is primarily developed considering working professionals, words such as workload in TO5 would be interpreted differently by the student group. When we observe items in Techno-insecurity, TIS1, TIS2, TIS3 all are related to threat due to new skills required and TIS4 and TIS5 are more focused

Table 1 Results of confirmatory factor analysis

	Techno overload	Techno insecurity	Techno complexity	Techno insecurity	Techno uncertainty	Academic productivity
TO1	.786					
TO2	.818					
TO3	.723					
TO4	.547					
TO5[a]	.489					
TI1		.695				
TI2		.716				
TI3		.741				
TI4		.759				
TC1			.675			
TC2			.795			
TC3			.691			
TC4			.710			
TC5			.806			
TIS1[a]				.159		
TIS2[a]				−.040		
TIS3[a]				.352		
TIS4				.761		
TIS5				.817		
TU1					.673	
TU2					.783	
TU3					.817	
TU4					.804	
P1						.835
P2						.851
P3						.834
P4						.834

[a] Items dropped

on peer pressure. Inter item correlation was also observed higher among TIS4 and TIS5. Therefore, only two items of the construct were retained for analysis.

The reliability of the technostress constructs was ascertained, before further analysis. Table 2 presents the reliability statistics and the key descriptive statistics of the technostress dimensions and academic productivity. The Cronbach alpha of all the measures was found to be more than 0.7, indicating an acceptable level of reliability and inter-item consistency of the scale (Nunnally, 1967).

Overall technostress level was found to be 3.15(on a scale of 5), which indicates a moderate level of technostress among students. Students had a positive perception of the role of technology in improving academic productivity, with a mean of 3.93. It is observed that overall students experience a moderate level of techno-overload (mean: 3.42), techno-uncertainty (mean:3.41), and techno-invasion (mean 3.31). Lower levels of techno-complexity (mean: 2.91) and techno-insecurity (mean: 2.68) is observed.

5.2 Level of technostress among various student groups

Technostress levels were compared between the different demographic profile of students. A series of independent sample t-tests were conducted to examine whether there exist significant levels of technostress among students grouped based on gender, age, level of education, and level of ICT experience. The results are presented in Table 3.

A comparison of technostress among male and female students revealed that female students experienced higher technostress than male students (t: 2.872, $p < 0.01$). Therefore, H1 was supported. Though the finding was in contradiction to earlier findings of employees in USA (Raghu-Nathan et al., 2008; Tarafdar et al., 2014) and China (Chen, 2015), it is consistent with technostress studies of students (Broos, 2005; Qi, 2019; Tekinarslan, 2008). Further, out of the five technostress components, female students experienced higher technostress in techno-complexity (t: 5.719, $p < 0.001$) and techno-uncertainty (t:3.241, $p < 0.001$).

The students were grouped into two age groups (18–22 and 23–28 years) and the differences in the levels of technostress observed. The t-tests results revealed that students in the age group of 23–28 years experienced higher technostress than the younger students of the age group 18–22 years (t:2.281, $p < 0.05$). Older student groups

Table 2 Measurement items reliability statistics

Construct	Number of items	Cronbach alpha	Mean	Standard deviation
Techno-overload[a]	4	0.787	3.43	0.78
Techno-invasion	4	0.781	3.31	0.87
Techno-complexity	5	0.843	2.91	0.83
Techno-insecurity[a]	2	0.701	2.68	0.93
Techno-uncertainty	4	0.790	3.42	0.64
Academic productivity	4	0.877	3.93	0.7
Technostress[a]	19		3.15	0.53

[a] Values after dropping items

Table 3 Comparison of technostress levels among various student groups

	Frequency (percentage) $N = 672$	Technostress level mean (standard deviation)	t-value	Significance level
Age			2.481	0.013*
18–22	535(80)	3.13(0.53)		
23–28	137(20)	3.25(0.54)		
Gender			2.872	0.004**
Male	373(55)	3.09(0.53)		
Female	299(45)	3.21(0.53)		
Level of education			3.427	0.001***
Undergraduate	359(53)	3.08(0.52)		
Postgraduate	313(47)	3.22(0.54)		
Years of experience of using ICT			2.160	0.031*
0–10 years	414(62)	3.2(0.53)		
More than 10 years	258(38)	3.1(0.53)		

*$p < 0.05$

**$p < 0.01$

***$p < 0.001$

experienced significantly higher levels techno-invasion (t:4.219, $p < 0.001$) and techno-overload (t:3.051, $p < 0.01$). The results supported H2 and were consistent with a recent study by Hauk et al. (2018). The analysis of students' level of education and technostress levels also showed significantly higher technostress among postgraduate students (t:3.427, $p < 0.001$) and stress was in particular, higher in techno-complexity (t:3.7, $p < 0.001$) and techno overload (t: 3.6, $p < 0.001$). The results indicated support for H3. Though there are no studies comparing technostress of undergraduates and postgraduates, the reason for higher technostress could be due to higher levels of academic workload for older students and postgraduates. Technostress induced by techno-overload is a common feature observed in postgraduates and older students.

The average number of years of experience with ICT in the sample was found to be 10 years. Therefore, students were grouped into two groups: those with ICT experience of 10 or less and those with more than 10 years of experience. The comparison of their technostress showed that students with lesser ICT experience experienced higher technostress levels (t:2.16, $p < 0.05$), and particularly higher in techno-complexity (t:4.498, $p < 0.001$), techno-insecurity (t:2.9, $p < 0.01$). The result was consistent with previous studies (Ragu-Nathan et al., 2008). Therefore, H4 was supported.

5.3 Technostress and academic productivity

To assess the impact of technostress on academic productivity, the structural model was assessed using AMOS 21. CFI (Comparative Fit Index) and TLI (Tucker Lewis Index) are popular goodness of fit measure in SEM and values closer to 1 indicates a good model. A cut-off value of 0.9 for CFI and TLI is considered to be an acceptable model

(Hair et al., 1998; Hu & Bentler, 1999). Lower values of badness-of-fit measures of Root Mean squared error of approximation (RMSEA) and Standardised Root Mean Square Residual (SRMR), closer to zero, indicates a good model (Kline, 2005). Hu and Bentler (1999) recommend a cut off value of 0.08 for SRMR and 0.06 for RMSEA. The standardized estimates and model fit indices are presented in Table 4.

The model fit indices for SEM, suggested by Hu and Bentler (1999), namely, CFI (0.920), TLI(0.910), SRMR(0.0728) and RMSEA(0.057) were found to be within acceptable cutoff criteria. The results also indicated a negative impact of technostress on academic productivity($p < 0.01$), therefore H5 was supported. The results were consistent with past studies on technostress on different groups of users (Tarafdar et al., 2007; Hung et al., 2011; Ayyagari et al., 2011; Tarafdar et al., 2011b; Lee et al., 2016).

Overall, among the five technostress dimensions, technostress induced by techno-uncertainty was found to be least. Techno-invasion was found to be the highest contributor of technostress among students. This could be due to the increasing ubiquity of technology, which has led to the invasion of personal time. Surprisingly, in contrast to previous literature (Hauk et al., 2018), technostress induced by techno-complexity is also experienced by this younger group of students. Our findings indicate that among students, the high-risk group that perceives technology as complex is older postgraduate level students, female students, and students with lesser ICT experience.

Table 4 : Results of structural equation model

	Standardised estimates
Academic productivity ← technostress	−0.136**
Techno-overload ← technostress	0.669***
Techno-invasion ← technostress	0.711***
Techno-complexity ← technostress	0.706***
Techno-insecurity ← technostress	0.632***
Techno-uncertainty ← technostress	0.284***
P1 ← academic productivity	0.785***
P2 ← academic productivity	0.832***
P3 ← academic productivity	0.806***
P4 ← academic productivity	0.781***
Model fit indices	
Chi-square (df)	706 (224)
Chi-square/df	3.152
CFI	0.920
TLI	0.910
SRMR	.0728
RMSEA	.057

**$p < 0.01$

***$p < 0.001$

6 Theoretical and managerial implications

The study makes an important theoretical contribution of cross-validating the technostress instrument of Tarafdar et al. (2007) among the students. The results indicate that the instrument is suitable to measure the prevalence of technostress among students, with minor modifications. However, there is a need to improve the Techno-insecurity scale for better reliability and accuracy, in the academic context.

The findings of the paper have several managerial implications for higher education institutions(HEIs). As the results indicate a higher impact of techno-invasion and techno-overload, HEIs must plan and schedule academic work in a manner that provides adequate time to complete the academic work and have a balanced lifestyle. HEIs can mitigate the impact of Techno-complexity by choosing user-friendly, familiar educational technology, and providing adequate training for the students.

It was observed that female students experienced higher levels of techno-complexity. The results are consistent with the results of technostress studies conducted on student population (Broos, 2005; Qi, 2019) and reiterate the need to identify at-risk students to help them cope with the technostress. As it was observed that older students, postgraduates, and students with lesser ICT experience had higher levels of technostress, HEIs must identify and train students, with lesser ICT experiences, during their admission to the program. HEIs need to conduct technology orientation sessions to increase the familiarization of technology, that would be used in their academic work. Also, special training sessions for those with lesser ICT experience would help mitigate technostress.

Results indicated that there is a negative impact of technostress on academic productivity. The results were consistent with the previous studies conducted in organizational contexts (Tarafdar et al., 2011a; Chen, 2015). HEIs may administer the technostress instrument among students to identify the high-risk students and counsel them to reduce technostress, thereby improving their academic performance. Students experiencing higher levels of technostress may be assigned a student mentor from the peer group, to improve the confidence of the student in the use of technology.

The results have implications for future employers as well. Results indicate the presence of technostress among the younger population, despite considerable higher ICT experience and popular belief that the younger generation is techno-savvy and have lesser technostress. It is necessary for employers that they do not take this group for granted and provide adequate ICT training for newly recruited employees to reduce burnout. As there are a variety of ICT applications, there is constant pressure to upgrade technical skills. Students also need adequate time to transition from academic to work life.

7 Limitations, scope of future research and conclusions

The study has a few limitations. The demographic characteristics of gender, age, experience with ICT, level of education were only considered for examining the technostress among students. However, past research shows that personality traits moderate the perceptions of technostress creators that impact the job outcome (Srivastava et al., 2015) and proactive personality traits reduce the negative effects of technostress (Hung et al., 2015). Future studies may include the personality traits of the students and test their impact on the technostress. Second, the study focused on technostress creators and did not include technostress inhibitors such as technical support provision, literacy facilitation, and involvement facilitation (Ragu-Nathan et al., 2008). Further research may investigate the association of techno inhibitor in solving the issues related to techno complexity and techno invasion. The techno-insecurity scale can be refined further to improve its reliability. It is therefore recommended to identify the sources of techno-insecurity among students.

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Appendix 1. Research Instrument

Age
Gender: Male/Female
Years of experience using ICT:
Education Level: Undergraduate/Postgraduate

Techno-overload

TO1. I am forced by this technology to work much faster.
TO2. I am forced by this technology to do more work than I can handle.
TO3. I am forced by this technology to work with very tight time schedules.
TO4. I am forced to change my work habits to adapt to new technologies.
TO5. I have a higher workload because of increased technology complexity. *dropped.

Techno-invasion

TI1. I spend less time with my family due to this technology.
TI2. I have to be in touch with my work even during my vacation due to this technology.
TI3. I have to sacrifice my vacation and weekend time to keep current on new technologies.
TI4. I feel my personal life is being invaded by this technology.

Techno-complexity

TC1. I do not know enough about this technology to handle my work satisfactorily.
TC2. I need a long time to understand and use new technologies.
TC3. I do not find enough time to study and upgrade my technology skills.
TC4. I find my peers know more about computer technology than I do.
TC5. I often find it too complex for me to understand and use new technologies.

Techno-insecurity

TIS1. I feel a constant threat to my performance due to new technologies. *dropped.
TIS2. I have to constantly update my skills to avoid poor performance. * dropped.
TIS3. I am threatened by classmates with newer technology skills. *dropped.
TIS4. I do not share my knowledge with my classmates for fear of poor performance.
TIS5. I feel there is less sharing of knowledge among classmates for fear of poor performance.

Techno-uncertainty

TU1. There are always new developments in the technologies we use in our institute.
TU2. There are constant changes in computer software in our institute.
TU3. There are constant changes in computer hardware in our institute.
TU4. There are frequent upgrades in computer networks in our institute.

Academic Productivity

P1. This technology helps to improve the quality of my academic work.
P2. This technology helps to improve my academic productivity.
P3. This technology helps me to accomplish more academic work than would otherwise be possible.
P4. This technology helps me to perform my academic work better.

Appendix 2: Summary of Modifications Done to the Original Instrument

Table 5 Summary of modifications done to the instrument

Construct	Original item	Adapted item	Comments
Techno-complexity (TC1)	I do not know enough about this technology to handle my job satisfactorily	I do not know enough about this technology to handle my work satisfactorily	“Job” was replaced with work
Techno-complexity (TC4)	I find new recruits to this organization know more about computer technology than I do	I find my peers know more about computer technology than I do	“New recruits to this organisation” replaced with “my peers”
Techno-insecurity (TIS1)	I feel constant threat to my job security due to new technologies	I feel a constant threat to my performance due to new technologies	“Job security” replaced with “performance”.In academic context poor academic performance or lower grades is a concern of students
Techno-insecurity (TIS2)	I have to constantly update my skills to avoid being replaced	I have to constantly update my skills to avoid poor performance	“Being replaced” substituted with “poor performance”
Techno-insecurity (TIS3)	I am threatened by coworkers with newer technology skills	I am threatened by classmates with newer technology skills	“Coworkers” replaced with “classmates”
Techno-insecurity (TIS4)	I do not share my knowledge with my coworkers for fear of being replaced	I do not share my knowledge with my classmates for fear of poor performance	Same as TIS2 and TIS3
Techno-insecurity (TIS5)	I feel there is less sharing of knowledge among coworkers for fear of being replaced	I feel there is less sharing of knowledge among classmates for fear of poor performance	Same as TIS2 and TIS3

Table 5 (continued)

Construct	Original item	Adapted item	Comments
Techno-uncertainty (TU1-TU4)	TU1:There are always new developments in the technologies we use in our organisation	TU1: There are always new developments in the technologies we use in our institute	In all items the word “organization” replaced with “institute”
Academic Productivity P1-P4	P1: This technology helps to improve the quality of my work	P1: This technology helps to improve the quality of my academic work	In all items, prefix of “academic” was added to terms “productivity” and “work”

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