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Investigating the impact of challenge and hindrance techno stressors on academic performance in online learning environments

Muhammad Z. I. Lallmahomed^{1*}

*Correspondence:

Muhammad Z. I. Lallmahomed
z.lallmahomed@mdx.ac.mu
¹Middlesex University Mauritius,
Coastal Road, Unicity,
Flic-en-Flac 90203, Mauritius

Abstract

In the post Covid-19 era, technology is now an integral part of the curriculum where in-classroom learning has been replaced by fully online and blended teaching. The rapid change to novel online learning environment, have left students exposed to the risks of techno stress. Given the dearth of studies on students, this research seeks to investigate the impact of challenge/hindrance techno stressors on students' satisfaction, burnout and engagement. Ultimately, the impact of these intervening variables on academic performance is examined. 198 students were surveyed, and results demonstrate that hindrance stressors are negatively related to satisfaction and engagement while contributing positively to burnout. Challenge stressors are positively related student's satisfaction and engagement. The findings also show that satisfaction partially mediate the relationship between both hindrance/challenge stressors and academic performance. Gender has been found to be moderating the relationship between hindrance stressors and burnout. Implications for higher education institutions are discussed.

Keywords Technostress, Eustress, Engagement, Satisfaction, Academic performance

1 Introduction

Higher education institutions worldwide have gone through major transformations in the ways they deliver their educational services due to the covid-19 pandemic [1]. In order to cope with this sudden change, higher education institutions (HEIs) had to face this new reality by replacing in-classroom learning with online teaching and learning [2]. The International Association of Universities (IAU) report suggests that two thirds of the institutions surveyed had moved to online teaching [3]. HEIs employed several online learning platforms to deliver courses [4]. Even after the pandemic, many HEIs are willing to continue with their online courses offering [5]. Moreover, HEIs are now embracing technology as an integral part of their curriculum by implementing fully online, blended teaching, flipped classroom and even massive online open courses [6]. However, students who are the main recipients of these leaning materials have been forced to adopt these new methods of learning with little to no prior training [7]. While lecturers may



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have been trained to cope with the new online platforms, much less attention has been given to students despite the drastic change in the delivery of the curriculum [8].

The rapid change to an online learning and move to a novel environment, have left students exposed to the risks of techno stress [9, 10]. Students had no time and prior training to adapt the new learning environment [11]. For instance, Petrie [12] contends that students experiencing psychological and emotional distress are unable to engage effectively with the class while those with a fixed mind experience difficulties with the new online learning environments [7]. Moreover, learning without the direct supervision of teachers could be a challenging process using online learning [4]. Yang et al. [13] further argue that the academic load placed on students in online learning setting is similar to those in face-to face sessions, hence leading to further strain.

Techno stress has been gaining much attention lately as technology is increasingly being used both in work place and in the private life of individuals [14]. Techno stress is a relatively young phenomenon and is still nascent in information system (IS) literature [9, 15, 16]. Prior empirical studies on techno stress in the IS literature have focused their attention mainly in the workplace [9, 17–19] while recent forays have been made in the social networking sites [20] and healthcare domains [21]. In doing so, the impact of techno stress on students have been neglected.

Current studies in higher education have mainly focused their attention on understanding teacher's techno stress and its impact [6, 22–24] while neglecting that of students [11, 25, 26]. Despite the numerous calls for further studies on techno stress [27, 28], there is a dearth of studies on higher education students despite being more exposed to the use of technology [26, 29]. The paucity of studies are based on the assumptions that higher education students are tech savvy and thus may not experience techno stress [30] but recent studies have shown the contrary [29, 31]. Stress is a context-specific phenomenon which needs to be investigated in a specific setting [18]. While majority of studies have conceptualised techno stress as representing solely negative outcomes in the workplace such as low performance [9, 16, 28, 32], techno stress can also have positive outcomes [21, 28] as well. This study aims to address this gap by further investigating the relationship between the dualistic effects of techno stress, students' engagement, burnout and satisfaction and ultimately its impact on academic performance in online learning environment using virtual classroom applications.

Moreover, investigating technostress amongst higher education students could help administrators to develop solutions to reduce technostress, increase satisfaction and academic performance, ultimately enhancing the quality of institutions [33]. Furthermore, the findings can help policy makers to devise necessary support to students experiencing stress [34]. Understanding the contribution of stressors to student's engagement and satisfaction can lead to better course design and delivery in online learning environments [35].

2 Literature review

2.1 Techno stress, stressors and strain

Techno stress has increasingly been getting attention in the IS literature with the extensive use of technology in nearly all spheres of life with, even more so with the advent of the Covid-19 pandemic [14]. Techno stress first appeared in the literature in 1984 by psychologist Craig Brod [9]. The latter argued that techno stress is a mental state that

describes individuals who are not able to deal with technologies [9]. Wang et al. [11] further states that techno stress arises as individuals are unable to adapt to the new requirements brought about with the use of technology. Techno stress is experienced by individuals during their use of an information system [28]. Stress is argued to arise when an individual's appraisal of a situation exceeds his capabilities and resources, thus representing a threat to that individual [15]. The misfit between the individuals and the environment results in negative outcomes [36].

Numerous studies on techno stress comprises of stressors (demands) and strain (outcomes) [28]. This process of stressor, stress and strain relies the transactional model of stress [37, 38] and has been employed extensively in the IS literature [39]. Tarafdar et al. [28] contend that the process of techno stress includes a set of features that have the potential to create demands in individuals, which are then appraised as stressors (demands). The demand appraisals require a response (coping responses) from the user, and this leads to an outcome (strain) for the user. Ayyagari et al. [9] further argue that the negative appraisals of the technology characteristics of an IS, may lead the user to experiences techno stress and thus leading to strains.

Majority of studies on techno stress have conceptualised this phenomenon as having a negative impact on individuals and organisations [21, 28] and thus leading to negative outcomes such as a drop in satisfaction or productivity [21]. However, Tarafdar et al. [28] contend that techno stress, may also lead to positive outcomes. The latter argued that technology characteristics can be appraised as being threatening and producing negative outcomes. However, the same IS characteristics can also present a challenge to individuals that lead to positive consequences. In the psychology literature, stress has also been argued to produce both positive and negative outcomes. For instance, Cavanaugh et al. [40] argued for the dual aspect of stressors comprising of challenge and hindrance stressors. Challenge stressors are assessed as beneficial while hindrance stressors as being harmful [21, 40, 41]. Studies examining the positive outcomes of stress are scarce in the IS literature [28, 39]. Additionally, few studies have reported positive effects of challenge predictors on desired outcomes [21, 42].

2.2 Stressors

Cartwright and Cooper [43] argue that stressors encountered in the work environment are factors that lead to stress. Raghu-Nathan et al. [16] suggests that there are two types of stressors; role related stressor and task related stressors such as task characteristics. In the organisational context, several underlying factors have been argued to lead to techno stress. For instance, the introduction of new technologies, increased complexity, ubiquity and associated job related uncertainties, lead to employees being perturbed and feeling weighed down [44]. Employees have had to cope with novel applications and adopt new workflows [16]. The fact of constantly being online, being called to carry out multiple tasks and technical issues also explains the advent of techno stress [45]. The IS literature denotes five main stressors that have been argued to lead to individual experiencing stress. These are techno-overload, techno-invasion, techno-uncertainty, techno-insecurity and techno-complexity [10, 15].

Techno-overload refers to the those factors that would drive an individual to do further work with the use of technology either to meet the demand placed on him or to deal with excess information and features [10]. Techno-invasion deals with the invasion

of privacy, where work life is encroaching on the individual's personal life. The use of technology allows for the users to be available at any time and the fear of being monitored [46]. Individuals experienced techno-uncertainty when they feel that they are not in control and they are not informed about policies or technology changes [10, 16, 47]. Techno-insecurity refers to the feeling of insecurity that users may have while using an information system as a result of thinking that colleagues are more knowledgeable than them [10]. Techno-complexity refers to the stress that individuals may experience due to their inadequate computer skills, the fact that being required to learn new skills and various issues that may happened with the technology such as interruptions [10, 47].

2.3 Strain

Outcomes resulting from experiencing techno stress have been called 'strain' [15]. Strain is the users' psychological response to the stressors [38]. Strain has been investigated as having a negative effect on the use of IS. Several negative outcomes related techno stress has been studied. In the job literature, studies have pointed out that individuals experiencing negative consequences such as lack of job satisfaction, work and role overload, role conflict, burnout and work family conflict [9, 10, 16, 46, 48]. It has also been shown that techno stressors negatively impact the employees' performance [18]. Strain has also been investigated in non-job context such as the SNS [28, 36, 49]. Results from these studies show that there is a positive relationship between techno stress and negative outcomes. For instance, individuals experience strain such as technology addiction [49], SNS dissatisfaction, use discontinuance [50, 51], concentration and sleep problems [36].

2.4 Techno stress in educational context

Studies which have investigated techno stress in the education sector have been mainly geared towards understanding teacher's level of techno stress and its consequences [22] while neglecting that of students [11, 25, 26]. Given the major changes in the curriculum, little to no consideration has been given to students [8]. Pokhrel and Chhreti [7] contend that teachers and student alike were compelled to adopt online systems with little to no preparations as there are no alternatives available. This has led to psychological and emotional distress amongst many students who have not been able to engage with the class effectively [12]. Moreover, Wang et al. [52] contend that online learning requires students to be more actively involved rather than being passive learners. Upadhyaya and Vrinda investigated techno stress amongst Indian private university students. They validated their instrument in the academic context and their study found out that students experience moderate level of techno stress which has a negative effect on academic productivity. Choquette-Cabrera et al. [53] investigated techno stress amongst secondary school students with regards to their mobile usage. They conclude that students using mobile devices experience greater techno stress than those who do not use the same. To the contrary, Qi [30] investigation into mobile devices use among university students found that there is no significant relationship between academic mobile usage and techno stress. Other studies have investigated student's techno stress from a person-environment misfit perspective [11, 30]. For example, Wang et al. [11] investigated students' techno stress from a person-environment misfit perspective. Their study demonstrates that the three dimensions of person-environment misfit framework have a significant relationship with techno stress, which leads to students experiencing burnout

and negative perceived performance. Zhao et al.'s [34] study show that students' techno stress is significantly related to their learning burnout and that necessary administrative support is required to deal with students' techno stress.

3 Theoretical model and hypotheses development

In this study, an investigation of challenge and hindrance stressors and their impact on outcomes such as academic performance with satisfaction, burnout and behavioural engagement as mediating variables was carried out. Drawing from education literature as well as the current studies on techno stress, the conceptual model is built as shown in Fig. 1.

Hindrance stressors are those that have negative impacts on the user's work due to hassles that users will have to go through in completing their daily routines [39]. Previous studies on hindrance stressors such as techno-overload, invasion uncertainty, insecurity and complexity have found that these stressors are negatively related to satisfaction [9, 54]. For instance, Ragu-Nathan et al.'s [16] survey of 216 government employees demonstrates that techno stress decreases satisfaction as well as continued use. Studies conducted by Fuglseth and Sørebo [55], Califf et al. [21], Christ-Brendemühl and Schaarschmidt [19] across different organisational settings show that techno stress inversely affects satisfaction, such that techno stress reduces satisfaction. Califf et al.'s [21] study of nurses in healthcare context concludes that hindrance stressors decrease job satisfaction and increases turn-over intention. Maier et al.'s study [39] on techno stress, show that techno stress indirectly impacts job satisfaction, through work-exhaustion. Other studies such as Suh and Lee [48]; Ayyagari et al. [9] suggests that techno uncertainty is a strong prediction of dissatisfaction. In the academic context, Zhao et al.'s [56] study amongst university students have shown that techno-distress adversely affects student satisfaction. Hence it is posited that:

H1 Hindrance stressors have a negative effect on student's satisfaction.

Burnout has been argued to be an important psychological response (strain) to techno stress [24, 41] and has been defined as "a state of emotional, physical and mental exhaustion caused by prolonged and excessive work-related stress" [57]. Due to its significance,

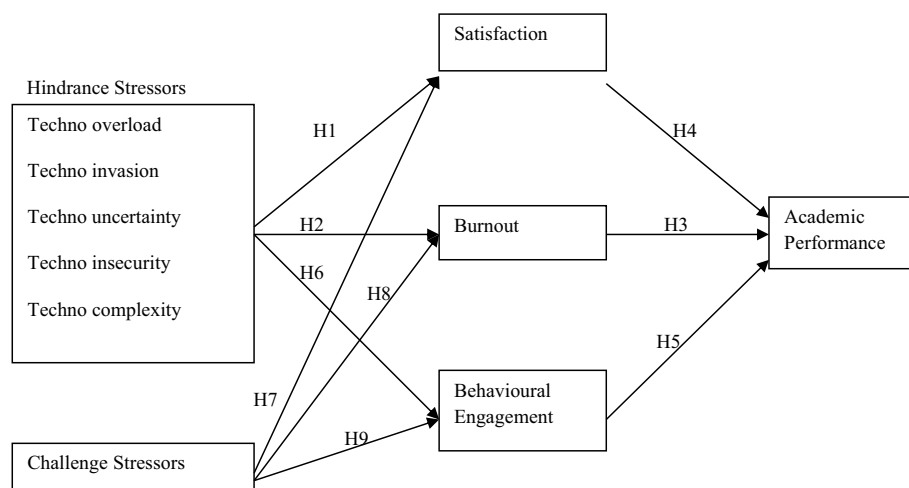


Fig. 1 Conceptual model

burnout has been receiving growing attention in the field of education [58]. Studies in the education sector show that teachers experience high level of burnout compared to other professions, leading to dissatisfaction and lower teaching quality [58]. However, students have also been argued to suffer from burnout as well [31] and scholars have investigated this phenomenon as learning burnout or study related burnout [59–61]. Within the educational context, burnout refers to study related emotional, physical and mental exhaustion [59, 62]. Moreover, Niu et al. [59] further state that there has been a dearth of research on burnout amongst students [63] while majority of studies have been on teacher's burnout instead [24]. Existing studies [29, 31, 64, 65] have found positive relationships between stressors and feelings of burnout. For instance, Xu et al.'s [66] study on stress amongst English language students suggests that when students perceived that learning tasks cannot be achieved despite efforts being made, these may lead them to desperation, hopelessness contributing to the feelings of burnout. Mafla et al. [64] investigated stress amongst dental education students and found that stress is positively related to burnout, with older, upper classes students being more at risks. Shrestha et al. [67] contend that first year medical students experiencing high levels of burnout due to medical entry exams. Moreover, more than 30% of college students report experiencing psychological distress and burnout due to extreme stress amongst Korean medical students [68]. Therefore, it is posited that:

H2 Hindrance stressors have a positive effect on burnout.

Studies investigating the relationship between burnout and academic performance have produced mixed results [69] and there are few theoretical frameworks to explain the potential relationships between burnout and academic achievement [70]. Previous studies have found negative [71–73], non-significant [74, 75] relationship between burnout and academic performance. These inconsistent findings may be due to different coping mechanism such as resilience which moderates the relationship between burnout and academic performance [70]. Other intervening variables such as self-efficacy have been shown to impact the relationship between burnout and academic performance as well. For instance, Schaufeli et al. [72] argue that students who are less efficacious may perform poorly compared to others. Travis and Bunde [76] found positive relationship between efficacy and performance.

Nevertheless, meta-analysis of 29 papers conducted by Madign and Curan [70] demonstrate shows that burnout has consistently been shown to have a negative relationship on academic achievement with a medium-sized effect. Madigan and Curan [70] further argue that burnout is a critical factor that should be given much attention while trying to improve student performance. Current studies investigating the relationship between burnout and performance have found that burnout leads to low performance [11, 49]. Liu et al. [63] contends that students tend to drop their learning tasks and comments as they experienced burnout, thus causing a reduction in their academic performance. For instance, Wang et al. [11] study amongst Chinese students has found a very strong negative relationship between burnout and academic performance. Therefore,

H3 Burnout has a negative effect on academic performance.

Following the Covid-19 pandemic, many institutions have had to move towards elearning systems into order to cope with the lockdown. Satisfaction has been argued

to be a good indicator of student's performance that contributes to the quality of online learning [77, 78]. Satisfaction is linked to the student's overall academic experience and achievement [79] and is shaped by those experiences in campus life [80]. Elliott and Shin [81] describe student satisfaction as the degree to which a student positively assesses the different results and experiences linked to their education.

Research investigating satisfaction and performance have produced mixed results. For instance, a study conducted by Maqableh and Alia [82] during the Covid-19 pandemic, demonstrate that students had to deal with several challenges while moving to online learning. These range from technological issues to mental health and juggling their personal lives alongside educational commitments. The findings also indicate that over one-third of the students surveyed expressed dissatisfaction with their online learning experience. Gopal et al.'s [83] study amongst Indian university students found out that there is a positive relationship between student's satisfaction and academic performance. Abuhassna et al.'s [35] study amongst undergraduate learners who were online learning users in Malaysia demonstrates that there is a strong significant relationship between students' satisfaction and students' academic achievements. They contend that student background, experience and interaction with online learning systems contribute to the satisfaction. Van et al.'s [33] study also demonstrate a significant positive relationship between satisfaction and performance, suggesting that services and teaching environment plays a critical role in forming student's satisfaction and performance. Lin et al.'s [84] study concludes that satisfaction is one of the major factors that lead to academic performance. However, research conducted by Rajabalee and Santally [85] in the Mauritian context amongst 665 university across different faculties have found that there is a weak positive relationship between satisfaction and performance as well as a weak but positive significant correlation between satisfaction and engagement. Nonetheless, due to the overwhelming support for positive relationship between satisfaction and academic performance, it is posited that:

H4 Satisfaction has a positive effect on academic performance.

Engagement, in its broad sense, is the quality of a student's involvement with activities that are concerned in schooling [86]. More precisely, student academic engagement deals with the effort and commitment that the student has with regards to learning throughout the student's schooling experience [87]. The engagement construct has received much attention by practitioners in the literature as it has been argued to be an important predictor of academic achievement and student performance [88–90]. Moreover, Kuh [91] further contend that students' engagement leads to the desired academic results. Engagement has also been deemed to be the precursor to students' active learning and interactions with technology [92]. For instance, Wang et al.'s [92] study on student engagement and latent profile analysis using large language models amongst Chinese university students demonstrate that students can be categorised into three groups each having different behavioural engagement patterns. Their findings also show that regular users are more likely to exhibit high engagement and less anxiety.

The literature denotes three types of engagement, namely: behavioural, emotional, and cognitive [86, 93]. Behavioural Engagement is defined as "student's involvement in learning and academic tasks, emotional engagement as students' affective reactions in the classroom, and cognitive engagement as psychological investment in learning" [93].

Since engagement is a multi-dimensional construct [31, 86], this present study focuses on the dimension that has been agreed upon by all conceptualisations: behavioural engagement [94–96]. Behavioural engagement is defined as the extent to which students are actively participating in the online learning activities. Studies on behavioural engagement and academic performance have shown that there is a significant positive relationship between those two constructs. For instance, Kang and Wu's [97] study shows that there is a positive relationship between behavioural engagement and academic achievement. Achievement refers to the students' grade outcomes [93]. Carmona-Halty et al.'s [98] research amongst 497 Chilean high school students demonstrates that academic engagement leads to academic performance and further contends that students experiencing positive emotions with the learning process, through proper academic engagement, are most likely to perform well. However, Carmona-Halty et al.'s [98] employed an overall measure of academic engagement and measured academic performance using GPA.

Contrary to the above, Alshuaibi et al. [99] shows that amongst the different engagement facets only cognitive engagement is positively related to academic performance. Their findings also show that behavioural engagement is not significantly related to academic performance. Previous studies have mainly investigated the relationship between behavioural engagement and academic achievement or learning performance [100–103] and found positive relationship between those constructs. Based on the above,

H5 Behavioural engagement has a positive effect on academic performance.

Stress has been argued to lead to students experiencing negative emotions, thus affecting their engagement with course materials [104]. For instance, Quigley et al. [105] contend that students studying online are often expected to engage with courses on their own. In doing so, there is a greater level of attrition as compared to in-class teaching [106], thus they will inevitably experience stress. Study carried out by Raufelder et al. [107] suggests that stress is negatively correlated to engagement. The authors contend that the more stressed that students are, the more disengaged the students will tend to be and thus leading to negative emotions. Saleem et al.'s [104] study on academic engagement and stress concludes that stress may reduce student's psychological resources, which in turn affect their engagement. Experiencing stressful situations may lead students to be disengaged with the programme and thus presents a risk of discontinuation [105]. Moreover, LePine et al. [108] showed that hindrance stressors are negatively affects learning motivation which can lead to disengagement.

H6 Hindrance stressors have a negative effect on behavioural engagement.

Cavanaugh et al. [40] argued for the two dimensional framework of stressors comprising of challenge and hindrance stressors. Challenge stressors are demands that are appraised as beneficial while hindrance stressors are appraised as being harmful [21, 40, 41]. Challenge stressors have also been argued to lead to the fulfilment of work place tasks such as usefulness, technical support, and involvement facilitation [21, 109]. In the technological context, the negative aspects of techno stress have also been referred to as techno-distress while the positive stressors as techno-eustress [15, 21]. Although several studies have been carried out on the negative outcomes of techno stress, there have been limited studies on techno eustress [28, 109]. Techno eustress can be defined

as the positive stress experienced by individuals in their utilisation of information systems [28]. Individuals experienced techno eustress or challenge stressors if they perceive technology as challenges to be tackled and surmounted, thus gaining opportunities for skill enhancement and a better work–life balance [21, 28].

Challenge stressors have been investigated in many diverse contexts. Most studies have researched this phenomenon in the organisational setting. Others have focused their studies on specific occupations such as Uber drivers [42] and healthcare services [21, 110]. Califf et al.'s [21] study amongst nurses showed that positive eustress leads to positive psychological responses and outcomes. In the context of higher education, research on techno-eustress is still nascent [111]. Sharma and Gupta [112] further contend that few studies have paid attention to techno eustress and its impact in technology enhanced learning environments. For instance, Wang et al. [113] study on techno stress amongst k12 teachers have found that challenge stressors contribute to enhancing intention to continue online teaching. Van Slyke et al. [5] investigated the effect of techno eustress on distance learning satisfaction and continuance intention. Their results show that techno eustress significantly increases satisfaction and continuance intention. Zhao et al. [109] investigated the effects of techno eustress on satisfaction and found a positive significant relationship. In line with Nascimento et al. [111], student will appraise challenge stressors as demands that can enhance growth and learning [50]. Moreover, challenge stressors exert a positive effect on outcomes as compared to distress. Therefore,

H7 Challenge stressors have a positive effect on satisfaction.

H8 Challenge stressors have a negative effect on burnout.

H9 Challenge stressors have a positive effect on behavioural intention.

4 Methodology

4.1 Data collection and measurement

A cross-sectional survey of undergraduate and postgraduate students was undertaken in a private university in Mauritius. After gaining the necessary ethical clearances from the university ethics committee, an online questionnaire was distributed to students. Using a convenience sampling strategy, an email was sent to students asking them to participate in the survey with a link to the online questionnaire. In total, out of 649 online questionnaires sent, 198 were returned with a response rate of 30%.

A 7-point Likert scale ranging from 'Strongly Disagree' to 'Strongly Agree' with neutral in between were employed. To check whether the data is appropriate for further analysis, the Kaiser-Mayer-Olkin (KMO) test in SPSS was used. The KMO measure of sampling adequacy is 0.905 which is above the threshold of 0.5 and Bartlett's test of sphericity is significant ($p < 0.05$), which suggest that further analysis can be conducted. The Mahalanobis Distance statistic to test was employed to detect outliers. 1 outlier was removed from the dataset. This resulted in 197 usable responses. Measures were changed to fit the context of virtual classroom. For instance, hindrance stressors were adapted from Ragu-Nathan et al. [16], Tarafdar et al. [32], challenge stressors were adapted from Cram et al. [42], behavioural engagement from Skinner et al. [86]. Perceived academic performance

was adapted from Jena [23]; Wang, Tan and Li [11] and finally burnout was adapted from Wang, Tan and Li [11]. More details on the construct are given in Appendix A.

5 Results

5.1 Descriptive statistics

Majority of the students were from 18 to 21 years old with 52% male and 48% female. Majority of the respondents were enrolled in a bachelors degree programme and 69% rated their computer skills as intermediate. The respondents have online classes 1 to 4 times per week to max duration of 9 h per week. Zoom was the preferred platform for virtual classroom. Table 1 provides further details on the demographics of the respondents.

5.2 Measurement model

SmartPLS version 4.0 was used to assess the model [114]. Constructs reliability and convergent validity were evaluated using Cronbach's alpha, composite reliability, and the average variance extracted (AVE). Cronbach's alpha values should be above 0.70 [115], composite reliability above 0.80 [116]. Factor loadings should be 0.70 and above and AVE should be 0.5 and above [117]. 2 items were removed from challenge stressor and behavioural engagement constructs respectively as they loaded below the threshold of 0.70. As shown in Table 2, the measurement items demonstrate acceptable convergent validity.

Discriminant validity was assessed using cross-loadings, Fornell-Larcker criterion and heterotrait-monotrait ratio (HTMT). Based on the HTMT results, items from techno invasion and academic performance were further culled from the analysis due to cross loadings. $\sqrt{AVE}$ is greater than the pair wise correlations between the constructs.

Table 1 Descriptive statistics

Description	Options	Frequency	Percentage (%)
Gender	Male	102	51.8
	Female	95	48.2
Age	Under 18	74	37.6
	18–21	86	43.7
	22–25	29	14.7
	26–29	3	1.5
	30–33	2	1
	34 and Above	3	1.5
	Foundation	6	3
Education	Bachelors	171	86.3
	Masters	20	10.2
Computer skills	Novice	21	10.7
	Intermediate	135	68.5
	Expert	41	20.8
Online classes (per week)	1–4 times	142	72.1
	5–8 times	45	22.8
	9 or more	10	5.1
Duration (per week)	1–9 h	138	70.1
	10–19 h	55	27.9
	20 or more	4	2
Virtual App Used	Kaltura	80	40.6
	Zoom	117	59.4

Table 2 Convergent validity

	Cronbach's alpha	Composite reliability (rho_c)	Average variance extracted (AVE)
Behavioural Engagement (BE)	0.89	0.93	0.82
Burn Out (BO)	0.86	0.90	0.70
Challenge Stressor (CS)	0.88	0.92	0.79
Techno Complexity (TCO)	0.87	0.91	0.72
Techno Insecurity (TINS)	0.82	0.89	0.73
Techno Invasion (TINV)	0.83	0.90	0.74
Techno Overload (TOV)	0.89	0.92	0.69
Academic Performance (AP)	0.86	0.91	0.78
Satisfaction (SAT)	0.87	0.92	0.79
Techno Uncertainty (TUN)	0.88	0.92	0.74

Table 3 Pair wise correlations among latent construct

	BE	BO	CS	TCO	TINS	TINV	TOV	AP	SAT	TUN
BE	0.90									
BO	− 0.35	0.84								
CS	0.51	− 0.24	0.89							
TCO	− 0.20	0.46	− 0.16	0.85						
TINS	− 0.24	0.70	− 0.14	0.67	0.86					
TINV	− 0.19	0.67	− 0.13	0.54	0.70	0.86				
TOV	− 0.30	0.69	− 0.19	0.58	0.68	0.67	0.83			
AP	0.54	− 0.38	0.58	− 0.21	− 0.28	− 0.16	− 0.35	0.88		
SAT	0.63	− 0.51	0.53	− 0.35	− 0.40	− 0.33	− 0.44	0.72	0.89	
TUN	0.10	0.31	0.11	0.50	0.44	0.39	0.39	0.07	− 0.05	0.86

Moreover, cross-loading differences were found to be below the threshold of 0.1 [118]. The HTMT criterion is below the threshold of 0.85 [119]. The Harman's single-factor test was conducted to evaluate common method bias. The results indicate that the largest explained variance by a single factor was 33%, with no single factor explaining more than 50% of the variance [120], nor did any single factor account for all variances. Furthermore, the variance inflation factors (VIFs) were lower than 5 [121], suggesting that the threat of common method bias is low in this study (Table 3).

In line with Ragu-Nathan et al. [88], techno stress was conceptualised as a higher order reflective construct. The two-stage approach [37] to calculate the scores for the higher order reflective construct 'Hindrance Stressor'. Following Sarstedt et al. [97], the lower order latent variables scores were saved in stage one and then used to measure hindrance stressors. Construct validity was re-examined. Cronbach's alpha and composite reliability were above recommended threshold (Table 4).

Based on the HTMT criterion and Fornell–Larcker criterion, the discriminant validity for higher order construct has been established (Table 5).

5.3 Structural model

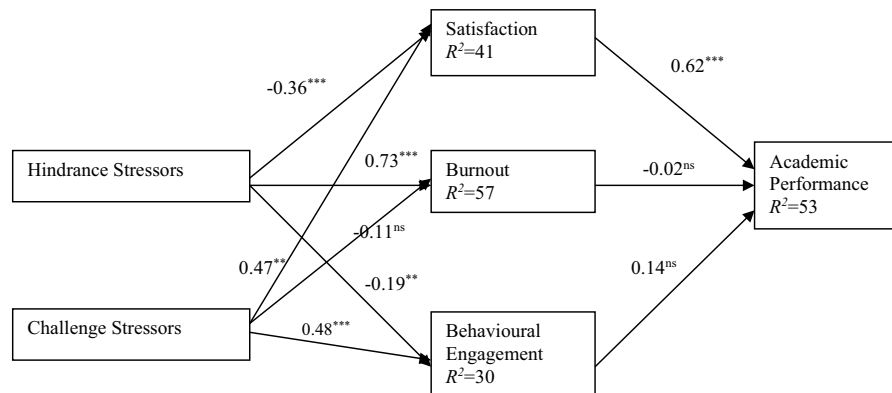
In order to assess the hypotheses, a bootstrap procedure with 5000 was used to generate t-statistics. The structural model (Fig. 2) reveals that 6 out of the 9 hypothesized relationships are statistically significant, as indicated in Table 6. The variance explained by the model is 30% for behavioural engagement, 57% for burnout, 41% for satisfaction,

Table 4 Convergent validity 2nd order construct

	Cronbach's alpha	Composite reliability (rho_c)	Average variance extracted (AVE)
Behavioural Engagement (BE)	0.89	0.93	0.82
Burnout (BO)	0.86	0.90	0.70
Challenge Stressor (CS)	0.88	0.92	0.79
Hindrance Stressor (HI)	0.88	0.92	0.73
Academic Performance(AP)	0.86	0.91	0.78
Satisfaction (SAT)	0.87	0.92	0.79

Table 5 Pair wise correlations among latent construct

	BE	BO	CS	HI	AP	SAT
BE	0.90					
BO	− 0.35	0.84				
HI	0.51	− 0.24	0.89			
LV hindrance	− 0.27	0.75	− 0.18	0.85		
AP	0.54	− 0.38	0.58	− 0.30	0.88	
SAT	0.63	− 0.51	0.53	− 0.45	0.72	0.89



Note: *ns* = non significant, * $p < .05$, ** $p < .01$, *** $p < .001$, R^2 = variance explained.

Fig. 2 Structural model**Table 6** Hypotheses and results

No.	Hypothesis	Path	T value	Significance	Supported
H1	HI → Sat	− 0.36	6.1	0.001***	Yes
H2	HI → BO	0.73	23.1	0.001***	Yes
H3	BO → AP	− 0.02	0.25	ns	No
H4	SAT → AP	0.62	8.9	0.001***	Yes
H5	BE → AP	0.14	1.74	ns	No
H6	HI → BE	− 0.19	2.66	0.01**	Yes
H7	CS → Sat	0.47	8.34	0.001**	Yes
H8	CS → BO	− 0.11	1.89	ns	No
H9	CS → BE	0.48	7.43	0.001***	Yes

ns non-significant, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

HI hindrance stressors, Sat satisfaction, BO burnout, AP academic performance, BE behavioural engagement, CS challenge stressors

and 53% for academic performance. Subsequently, a discussion of the key findings is presented.

Next, a post hoc analysis was conducted to test for mediation of satisfaction, burn-out, behavioural engagement in the relationship between hindrance/challenge stressors and academic performance. Using the steps recommended by Hair et al. [122], as shown in Table 7, it was observed that there is a significant indirect effect between challenge stressors and academic performance ($\beta = 0.262$, $p < 0.001$). The total effect of challenge stressors on academic performance is significant ($\beta = 0.361$, $p < 0.001$) as well as with the inclusion of the mediator satisfaction ($\beta = 0.262$, $p < 0.001$). The indirect effects 95% Bootstrap CI Bias Corrected: [LL = 0.172, UL = 0.340] do not straddle a 0 in between indicating there is mediation [123, 124]. Hence, this shows that satisfaction partially mediated the relationship between challenge stressors and academic performance. In the same token, the results also show that satisfaction fully mediates the relationship between hindrance stressors and academic performance.

The moderating effect of gender was also examined in the post-hoc analysis. Meta-analysis carried out by Purvanova and Muros [125] over 183 studies demonstrates that there are significant differences between men and women with regards to burnout. Jeon et al.'s [68] study on the general characteristics revealed significant differences in academic burnout by gender Korean university students. Moreover, comprehensive review of the literature, Demerouti [126] suggests that demographic factors such as gender may impact burnout.

As shown in Fig. 3, gender has been found to be moderating the relationship between hindrance stressors and burnout ($\beta = 0.25$, $p < 0.01$). On a granular level, the effect size of the different predictors on their dependent variable was examined. Effect sized (f^2) of 0.35, 0.15, and 0.02 are considered large, medium, and small (21). Challenge stressor has a medium effect on behavioural engagement ($f^2 = 0.25$) and medium to large effect on satisfaction ($f^2 = 0.31$). With regards to the techno stress constructs, techno-insecurity ($f^2 = 0.15$) and techno-overload ($f^2 = 0.12$) has a medium to small effect on burn out.

Table 7 Results of mediation analysis

Total effects	Direct effect	Indirect effect	95% Bootstrap CI		Mediation
			LL	UL	
HI → AP − 0.200***	HI → AP 0.059 ^{ns}	HI → Sat → AP − 0.196***	− 0.281	− 0.118	Full mediation
		HI → BO → AP − 0.051 ^{ns}	− 0.173	0.075	No mediation
		HI → BE → AP − 0.012 ^{ns}	− 0.051	0.017	No mediation
CS → AP 0.546***	CS → AP 0.262***	CS → Sat → AP 0.247***	0.172	0.340	Partial mediation
		CS → BO → AP 0.008 ^{ns}	− 0.007	0.037	No mediation
		CS → BE → AP 0.030 ^{ns}	− 0.042	0.114	No mediation

ns non-significant, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

HI/hindrance stressors, Sat/satisfaction, BO/burnout, AP/academic performance, BE/behavioural engagement, CS/challenge stressors

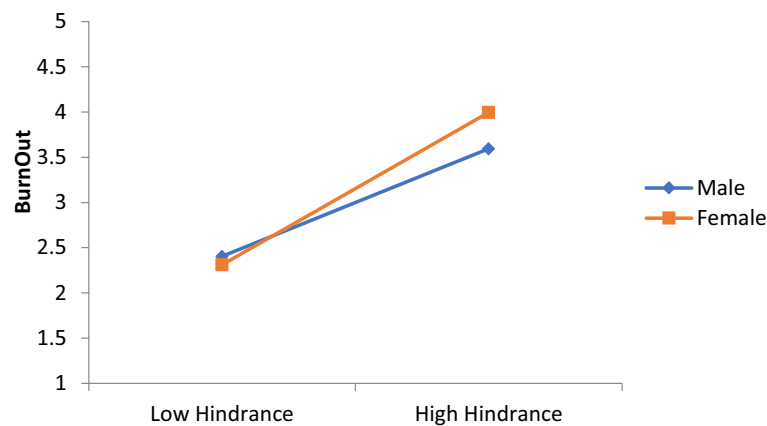


Fig. 3 Slope analysis—moderating effect of gender

6 Discussion

Following the gap in the literature on the dualistic view of techno stress [21, 28] and calls for further studies in academic context, this study sets out to investigate the positive and negative the effects of techno stress on students' satisfaction, engagement, and burnout. Additionally, the impact of students' satisfaction, engagement, and burnout on their academic performance was explored. The results demonstrate that hindrance stressors contribute to student's burnout whilst reducing student satisfaction and behavioural engagement in online learning environments. Challenge stressors on the other end, are positively related to the student's satisfaction and behavioural intention. The results also show that satisfaction fully mediates the relationship between hindrance stressors and academic performance and partially mediates the relationship between satisfaction and academic performance. These findings make a significant contribution to advancing the extant literature on stressors in the education sector in several ways. Firstly, given the dearth of studies on technostress in higher education, this study investigates both the positive and negative aspects of technostress in online learning environments. It conceptualises challenge stressors and extends its applicability in the higher education sector. The results further enhance the understanding of the relationship between hindrance/challenge stressors and student's involvement in learning and academic tasks. Finally, the findings provide both theoretical and practical relevance, offering valuable insights for educators, policymakers, and technologists seeking to design inclusive and effective e-learning systems.

Hindrance stressors have been shown to negatively predict the relationship with both student's satisfaction and behavioural engagement and have a strong positive relationship with students feeling of burnout. These suggest that students experiencing distress with the use of online learning environment will mostly likely be dissatisfied with such system as well as their learning process. In doing so, they will reduce their behavioural engagement which may further impact on academic standing [104]. Moreover, Quigley et al. [105] contend that this presents a risk of discontinuation. These results further contribute to enhancing the discussion on the relationship between hindrance stressors and student's involvement in learning and academic tasks.

The results show that challenge stressors are positively related to behavioural engagement. These findings suggest that students, who view the online learning as a challenge that they will have to overcome, will put in the necessary efforts to engage with the

materials using online learning platforms. Moreover, in line with Califf et al. [127] and Zielonka [128] in the work-related domain, the findings indicate that challenge stressors have a positive significant relationship with satisfaction in students' learning. Students view the online learning environment as an opportunity to learn and improve their skills, which leads to increased satisfaction and involvement [21, 109, 111]. Moreover, Chhetri and Baniya [129] contend that positive emotions lead to satisfaction. Challenge stressors have a negative non-significant relationship with burnout, suggesting that students' positive stress has no impact on exhaustion. This calls for more studies in different contexts. Perceiving the online learning platform as useful and user-friendly can lead to active student engagement and reduce feelings of exhaustion. Moreover, students who experience positive stress, views the online learning environment as an opportunity for self-improvement, which helps prevent exhaustion.

Contrary to previous studies [11, 49, 100], there are no significant relationship between burnout and academic performance. This shows that in this context, students adapted quickly to online learning and thus exhaustion with their studies is not affecting their overall performance. Further studies on burnout and academic performance have shown that intervening variables such as resilience can affect the nature of this relationship. Resilience refers to as an individual's ability to cope and recover from stress [130]. Cherry et al. [131] contend that resilience contributes to reducing burnout and is deemed as a key skill to deal with stress in academic environments. Studies have found that resilience fully mediates the relationship between burnout and academic performance [70, 132, 133]. For instance, Serefica and Muria [133] argue that students present very resilience which may contribute to mitigating the effects of burnout. Moreover, Madigan and Curran [70] further argue that factors such as measuring instrument use, the level of education, the choice of measures for academic performance as well as gender may moderate the relationship between burnout and academic performance.

As techno stress has been argued to be investigated in their own social context, results may vary in different settings. Behavioural engagement has also been found to have no significant impact on academic performance. This study confirms the findings of Alshuaibi et al. [99] who found similar results. This may suggest that students are already aware of the expected behaviour and are being guided by their teachers through the online learning platform. Our results also demonstrate that satisfaction is the only significant predictor of academic performance. Moreover, the relationship between challenge stressors and academic performance is partially mediated by satisfaction whereas satisfaction fully mediates the relationship between hindrance stressors and academic performance. In line with previous studies [33, 35, 84], the results show that satisfaction is a very important and critical factor in online learning environments. Maintaining and improving overall positive academic experience through provision of proper support and services with the e-learning platform contributes to the students' academic performance [35, 84]. Following an investigation of moderation analysis, gender has been found to be moderating the relationship between hindrance stressors and burnout. Slope analysis (Fig. 3) shows that females are more likely to suffer from burnout than males in an environment where high techno-distress is present. These findings go in line with current body of research that have examined effects of gender on burnout. For instance, women have been shown to experience higher levels of exhaustion compared to men [125]. Several studies found that the feeling of burnout was more pronounced in females

than males [68, 134, 135]. These results are important to policy makers in the design in interventions to reduce stress and burnout.

7 Practical implications

Several implications for practice can be derived from this study. For instance, hindrance stressors have been found to decrease both satisfaction and behavioural engagement whilst contributing to the feelings of burnout. Practitioners should endeavour to minimize the effect of hindrance stressors through proper facilitating conditions. The adoption literature has shown that facilitating conditions such as IT support, stable connections can lead to the successful uptake of a technology [136]. The availability of support staff should be provided to help students with any technical issues that they may require. Moreover, techno-insecurity has been shown to have a medium effect on burnout. Students feel that they may be disadvantaged through online platforms as they perceive that their peers may know more than them. Hence, academic institutions should come up with a proper training plan so that students can familiarise themselves with the online environment and its features beforehand. Training has been argued to reduce user's techno stress and lead to positive emotions with the use of technology [23].

Techno-overload has also been found to have a medium-small effect on burnout. Students may feel apprehensive that using online platforms would require them to do more work than in face-to-face classes. Given the numerous features that online environment provides such as online quiz, video, group work amongst others, teaching methods and lectures must be re-engineered so as not to overload students with information and tasks. Large online sessions could make use of teachings assistants to attend to students' queries. It is not sufficient for higher learning institutions to have fast speed internet and learning materials geared towards online learning. HEIs must also consider facilities available at students' premises. As not every student will have the same setups, this disparity can contribute to further exacerbating techno-insecurity and overload, leading to burnout. This study also demonstrates that female students are more likely to experience burnout than their male counterparts. This shows the need for targeted and customized strategies to reduce burnout. The use of gamification coupled with peer-learning opportunities could simulate a more inclusive and stimulating academic environment.

Challenge stressors contribute positively to behavioural engagement and satisfaction. Positive affect is vital in forming students' emotions towards online learning platforms [111]. Thus, challenge stressors contribute to keeping students engaged with the learning materials. Moreover, students may feel a sense of accomplishment by overcoming those challenges and further contribute towards satisfaction with online learning. Satisfaction with online learning environment has been shown to improve academic performance. Therefore, academic institutions should ensure that the online learning environment employed, is user-friendly, useful and reliable. Proper consultation and design of these services must be carried out with relevant stakeholders. Moreover, they should ensure that students do not lose interest by keeping the students actively involved throughout the teaching process. Nkomo et al. [137] suggest that proper design of learning environment influences the learning process and support retention.

8 Conclusions

This study answers the calls for further research into the impact of hindrance/challenge stressors in the academic context. The results demonstrate that hindrance stressors lead to student burnout and lower satisfaction and behavioural engagement in online learning. Contrary to the above, challenge stressors enhance student satisfaction and engagement. Additionally, satisfaction fully mediates the relationship between hindrance stressors and academic performance and partially mediates the relationship between challenge stressors and academic performance. The findings contribute to the literature on challenge/hindrance techno stressors and their impact on students' satisfaction, burnout and behavioural engagement. Moreover, this study also investigates the indirect effect of the both challenge/hindrance techno-stressors on academic performance and enhances the discussion on dualistic nature of stress and outcomes amongst students in the higher education sector. Finally, this study makes valuable recommendations to administrators and policy makers alike on interventions that could made to mitigate the effect of technostress and improve satisfaction, engagement and academic performance.

The findings of this study must be read in light of the following limitations. Generalisations should be done with caution as techno stress is dependent on the context of the study. This study was carried out in a private university in a developing state; hence findings may not apply to developed countries. Moreover, data was collected at a single point in time using a convenience sampling strategy. The sample size employed may limit generalisability of findings. Self-reported measures of academic performance were employed as compared to more objective measures. These may constrain the ability to draw comparisons with studies employing objective measures.

Future studies could investigate the effect of challenge/hindrance stressors as well as engagement using an objective measure of academic performance such as GPA or academic achievement. The effects of intervening variables such as gender, resilience, institutional support, self-efficacy on the relationships between stressors and academic performance could be further investigated. Future studies could employ a stratified sampling approach across multiple institutions and varied geographic/socio-economic contexts. These would allow for subgroup analyses, such as interactions between stressors and individual differences like resilience. This study makes use of a cross-sectional survey, a longitudinal study could offer a more robust explanation of the effect of technostress and its impact on students in the higher education settings. Moreover, researchers could explore the use of mixed methods, combining both qualitative and quantitative methods for a richer explanation of those causal links. This study makes use of a single dimension of engagement. Future works could investigate the cognitive and emotional dimensions of engagement for a holistic understanding of the interactions between stressors and academic performance in online learning environments.

Supplementary Information

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Supplementary Material 1

Author Contributions

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Data availability

Data can be made available upon reasonable requests.

Declarations**Competing interests**

The authors declare no competing interests.

Ethical guidelines/accordance

Middlesex University Mauritius Ethics Committee: All protocols associated with the current study were approved by the Middlesex University Ethics Committee. Project ID: 21656. The present study was conducted in accordance with the Middlesex University Code of Practice for Research. Project ID: 21656.

Informed consent

Informed consent was sought from the participants before proceeding with this study.

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