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Analysis of technostress experienced by students at the university of cape town, during the COVID-19 pandemic

Gordon Cook, *University of Cape Town, ckxgor001@myuct.ac.za*
Jean-Paul Van Belle, *University of Cape Town, jean-paul.vanbelle@uct.ac.za*

Abstract

Information and Communication Technology (ICT) is used to improve the quality of many people's lives. However, heavy reliance on ICT can lead to technostress, causing health and productivity problems. Technostress has been analysed in organisations, but not in a university context, especially under remote learning during COVID-19. The purpose of this paper is to provide an explanatory contribution to knowledge regarding university students' experiences of technostress and how it impacts their academic productivity and performance. The data for this paper was collected using an online questionnaire among the students of one leading research university in Africa and used to test hypotheses related to a technostress theoretical model. The data was gathered from a convenience sample of 100 student responses. A technostress model (based on transaction theory of stress) was formed for hypothesis testing. Some hypotheses were not supported, but those that were indicated that universities should ensure that techno-complexity is reduced, and remote learning environments are improved. It was also found that technostress has a negative impact on academic productivity and performance, and that coping mechanisms can moderate the relationship between technostress and academic productivity and performance. The findings related to student remote learning environments and the moderating effect of student coping mechanisms are unique to this study.

Keywords: technostress, COVID-19, student learning, academic productivity, academic performance, information and communication technologies (ICT)

Introduction

Information and Communication Technology (ICT) is highly pervasive in modern society, offering benefits such as improved productivity and better work quality (Hughes et al., 2017). However, the benefits of ICT can come at the cost of stress for the user, specifically referred to as "technostress" (Dragano & Lunau, 2020). Technostress has been linked to health problems (Tarafdar et al., 2015) and other employee performance issues in the workplace (La Torre et al., 2019). There is little research conducted in the context of universities, looking at students. There have been specific creators and inhibitors of technostress identified in literature (Atanasoff & Venable, 2017). However, most technostress research has been conducted in an organisational context, meaning some creators and inhibitors may have a different impact on students who are younger and considered native to the digital age (Upadhyaya, 2021). The aim of this paper is to explore the experiences of technostress in students at the University of Cape Town (UCT), and explain the relationship between technostress and academic performance.

ICT technology should be used to improve efficiency and quality of life (La Torre et al., 2019). Students at UCT should be able to use technology to enhance their performance and improve their academic productivity with the use of ICT. However, ICT use can lead to technostress, where wellbeing and productivity are impacted. COVID-19 lockdown has forced remote working, increasing the reliance on

ICT. Most literature has analysed the technostress phenomena in an organisational setting and not at a university, looking at students (Upadhyaya, 2021). The shift to remote working required university students to learn away from campus settings, which most students had grown accustomed to. To continue learning remotely, students had to rely on ICT platforms to execute tasks they would normally perform without ICT platforms. These tasks included attending lectures, tutorial sessions, and group project meetings, among other online activities. Some of these tasks are not best suited to working remotely with ICT but have left students no choice but to use them.

The main research question for this paper is "under COVID-19 remote working conditions, what is the impact technostress has had on senior UCT student's academic productivity, and how can the impact be reduced?". This can be broken down into the following sub-questions in the remote working context:

- RQ1: What are the factors that create and inhibit technostress in individuals?
- RQ2: What is the relationship between technostress and students' academic productivity?
- RQ3: How are the findings from the research consistent or inconsistent with existing literature?

Literature Review

Technostress

Physical symptoms such as restlessness, headaches, and fatigue have been linked to the technostress phenomenon (Tarafdar et al., 2015). Mental symptoms of technostress include irritability, depression, behavioural changes, decreased sexual desire, crying spells and apathy (Chiappetta, 2017). However, identifying these symptoms has a subjective element to them and one individual may or may not display the same symptoms as another individual (Chiappetta, 2017).

The factors that increase technostress are generally accepted to be techno-overload, techno-invasion, techno-complexity, techno-insecurity, and techno-uncertainty (Dragano & Lunau, 2020; La Torre et al., 2019; Srivastava et al., 2015; Tarafdar et al., 2015; Upadhyaya, 2021; Wang, K. et al., 2008). Techno-overload describes a situation where the use of new technologies puts pressure on individuals to work faster and for longer (Srivastava et al., 2015). Techno-invasion describes the effect technology has on individuals when it disrupts their personal lives and forces them to work for longer than regular hours (Upadhyaya, 2021). Techno-complexity is defined as the way technology challenges an individual's concentration, feeling of control, and qualification to use the technology, based on the technology's intricacy (Dragano & Lunau, 2020). Techno-insecurity is characterised by an individual feeling threatened by technology, where it might cost them their job or status in an organisation (La Torre et al., 2019). Techno-uncertainty is caused by becoming stressed about frequent technological upgrades and changes (Tarafdar et al., 2015).

Some key factors that reduce technostress are technical support provision, literacy facilitation, and involvement facilitation (Atanasoff & Venable, 2017). Technical support provision denotes the supply of assistance to an individual or end-user when a new ICT is implemented in a certain context (Sarabadani et al., 2018). Literacy facilitation refers to teaching and improving the skills of individuals regarding their use of ICT in the workplace (Ahmad et al., 2014). Involvement facilitation denotes the methods used to improve the level of engagement an individual has with new or upgraded ICT (Fuglseth & Sørebø, 2014).

In a business environment, technostress has been seen to negatively impact employees, leading to higher absenteeism, higher levels of conflict, greater employee isolation and an overall reduction in professional effectiveness (La Torre et al., 2019). Most of the analysis surrounding technostress and its wellbeing implications have been conducted in an organisational setting and not at universities, where the mean age of individuals is lower (Upadhyaya, 2021). These younger students are considered natives to the digital

age, implying that they are technologically fluent and able to adapt to technology demands with greater ease, compared to their older counterparts (Upadhyaya, 2021). This ability to adapt, may have different implications for technostress in students.

Remote Working

With the outbreak of COVID-19 in 2020, millions of people across globe shifted to remote work, with very little experience in working remotely (Wang et al., 2021). The impact of this change was felt very deeply in institutions such as businesses and schools, where working remotely is not the norm (Spagnoli et al., 2020). The qualitative study conducted by Wang et al. (2021) found that the interference of work in the home environment during the COVID-19 pandemic was a challenge that was mentioned the most by respondents. This interference of work in the home environment is a form of techno-invasion, one of the five factors that increase technostress in an individual (Upadhyaya, 2021).

Some universities have implemented online learning as an expansion of existing technology infrastructure, resulting in less disruption (Ali, 2020). However, not all universities managed to avoid disruption. Educational institutions can assist students by focusing on the way educators use their voice during teaching. Other inputs such as facial expression and body language can sometimes be missing or unavailable during online instruction, meaning communication is sometimes incomplete or inaccurate (Rahiem, 2020).

Coping Mechanisms

Transaction theory of stress states was pioneered by Lazarus & Folkman (Lazarus & Folkman, 1987), who state that there are three processes that are used to confront stress: primary appraisal, secondary appraisal, and coping. Primary appraisal involves the process of identifying a threat to oneself, secondary appraisal is the process of assessing the available resources that can aid in coping with the perceived threat, and coping involves the execution of the mechanisms to lower the consequences of the initial threat (Biggs et al., 2017). The five factors that increase technostress can be linked to primary appraisal, because the factors can reveal that there is an imbalance between the demand technology is placing on them and their ability to meet said demand (Hauk et al., 2019). Common secondary appraisal efforts can be broken down into three main forms: active coping, seeking instrumental social support, and behavioural disengagement (Hauk et al., 2019). Active coping may take the form of gaining control of the situation or threat and seeking social support may manifest as asking for assistance in dealing with the threat. Conversely, behavioural disengagement does not aim to take control of the threat or find resources to assist, instead it can appear in the form of ignoring the threat, denial of the threat, or ceasing all interactions with the stressful situation entirely. Notably, it is possible for an individual to engage in multiple strategies concurrently, meaning these coping strategies are not mutually exclusive to each other (Biggs et al., 2017).

Literature contains an alternative to transaction theory which is the job demands-resources framework. This framework is targeted at the work environment and Zaza et al. (2021) encourages supervisor support to combat the burnout of IT professionals. However, this framework does not fit well in a university context, because students do not have a supervisor relationship and students use ICT for educational purposes, instead of meeting a job demand like an employee. Transaction theory is the prevailing framework for analysing technostress (Pirkkalainen et al., 2019). The advantage of using this framework to analyse the technostress of university students is because it focusses on the relationship between stressors and the outcomes of said stressors, independent of a work environment (Pirkkalainen et al., 2019). This makes the framework more versatile in its application and suitable for a university context where the previously mentioned IT stressors exist.

Tobin et al. (1989) developed the most widely accepted classification of coping, where the execution of coping can be sorted into two groups: engagement and disengagement. These two groups can be separated

further into strategies that either address the stressful problem or the emotions of the individual (Tobin et al., 1989). Problem-focused coping involves the individual confronting the issue or threat to resolve the situation, whereas emotion-focused coping involves the individual finding ways to improve their emotional state to deal with the problem (Salas et al., 2017). Engagement mechanisms and disengagement mechanisms are also referred to as functional and dysfunctional coping mechanisms respectively (Hauk et al., 2019). Active coping and seeking instrumental social support are considered functional coping mechanisms, whereas behavioural disengagement is considered a dysfunctional coping mechanism (Hauk et al., 2019).

Research Design

In the survey conducted on the target audience, a model was created with technostress as a dependent variable. The various factors that were the independent variables in the model are listed below. As shown in **Error! Reference source not found.** below, there are five aspects of technostress that were tested as factors that increase technostress: techno-overload, techno-invasion, techno-complexity, techno-insecurity, and techno-uncertainty. There were three technostress-reducing factors that were tested: technical support provision, literacy facilitation, and involvement facilitation. The relationship between the factors that increase technostress and technostress, the factors that reduce technostress and technostress, digital literacy and technostress, remote learning environment and technostress, and technostress and academic productivity were tested. The final item that was tested is how coping mechanisms moderate the relationship between technostress and academic productivity.

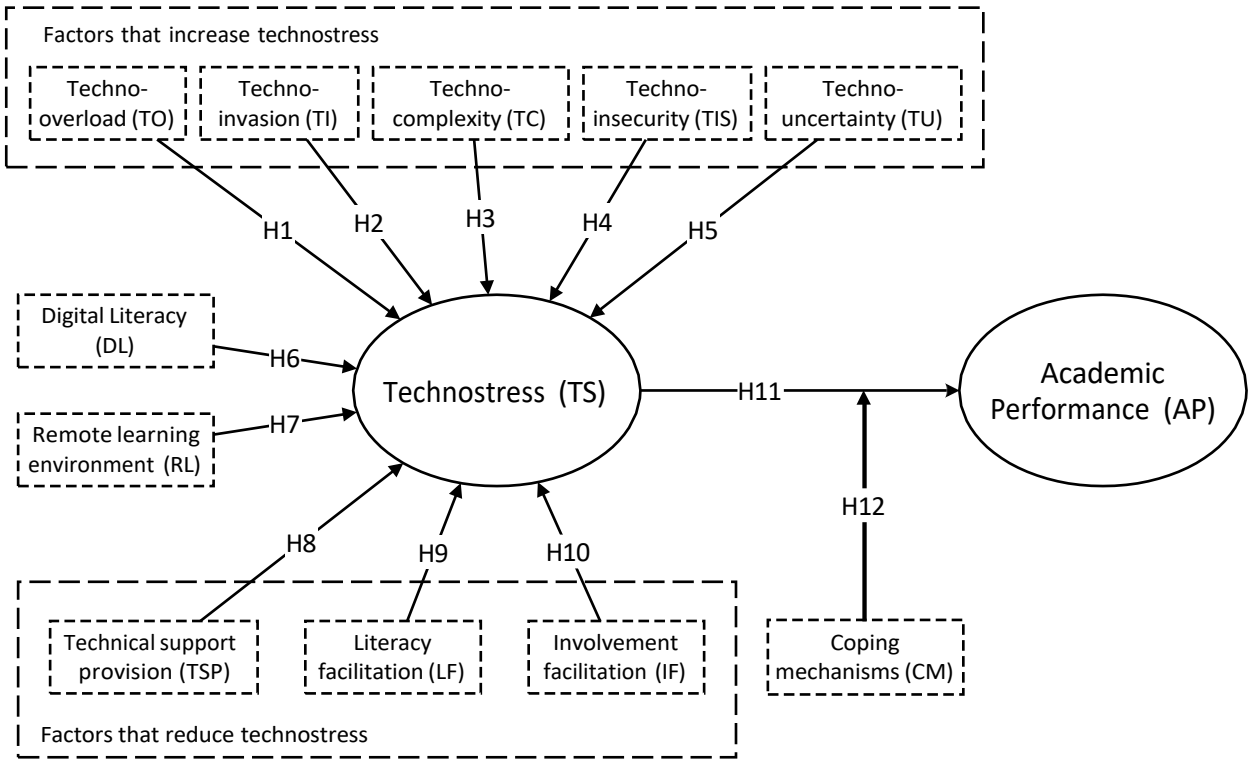

Figure 1: Technostress Model. Adapted from Upadhyaya (2021) and Ragu-Nathan et al. (2008)

A questionnaire was designed with at least 3 test items for each construct in the model. Some test items were based on existing questions from literature referenced in the Literature Review. The test items (and their questions) for the factors that increase and reduce technostress were adapted from Upadhyaya (2021) and Ragu-Nathan et al. (2008), to fit the UCT context. The test items for digital literacy, remote learning environment, and coping mechanisms were included in the model based off existing literature, but the

questions were original. Assessing the impact of the remote learning environment is unique to this study. All questions were designed to be answered using a seven-point Likert scale, allowing for sufficient resolution given the educated audience. The odd number of Likert scale points allows respondents to be neutral in their response if necessary.

Hypotheses

Based off the literature review and the model **Error! Reference source not found.** above adapted from Upadhyaya (2021) and Ragu-Nathan et al. (2008), the following hypotheses were presented:

- H1: There is a positive relationship between techno-overload and technostress.
- H2: There is a positive relationship between techno-invasion and technostress.
- H3: There is a positive relationship between techno-complexity and technostress.
- H4: There is a positive relationship between techno-insecurity and technostress.
- H5: There is a positive relationship between techno-uncertainty and technostress.
- H6: There is a negative relationship between digital literacy and technostress.
- H7: There is a negative relationship between remote learning environment and technostress.
- H8: There is a negative relationship between technical support provision and technostress.
- H9: There is a negative relationship between literacy facilitation and technostress.
- H10: There is a negative relationship between involvement facilitation and technostress.
- H11: There is a negative relationship between technostress and the academic performance of students.
- H12: Coping mechanisms moderate the relationship between technostress and academic performance of students.

Of the twelve listed above, hypotheses 1-5 and 8-11 are replications of previous studies, in the UCT context. Hypotheses 6,7, and 12 are unique to this study.

Research methodology

The research adopted the positivist philosophy because it relied on a hypothetico-deductive method to test hypotheses (Park et al., 2020). The hypothetic-deductive model requires generated empirically testable hypotheses. This research is therefore deductive in nature.

The target audience for the survey was full-time UCT students in their second, third or fourth year of study. The link to the online questionnaire was distributed through Outlook with the assistance of the UCT Department of Student Affairs (DSA) research invitations. The data collection was anonymous and gathered through an online tool (Qualtrics). The tool that was used for the statistical analysis of the quantitative data was Statistical Package for the Social Sciences (SPSS).

Data Analysis, Findings, and Discussion

The data analysis section will first provide highlights of the descriptive statistics for the factors of the technostress model. Appendix A provides a summary table of descriptive statistics for each factor's questions. Following the descriptive statistics, the tests for reliability and validity will be presented. Lastly, the technostress model will be assessed and re-evaluated based off the results of the reliability and validity tests.

Technostress, and Coping Mechanisms

First, the descriptive statistics for two key variables, namely academic performance, and coping mechanism factors are presented. Descriptive statistics and their discussion for the independent variables are omitted due to space considerations.

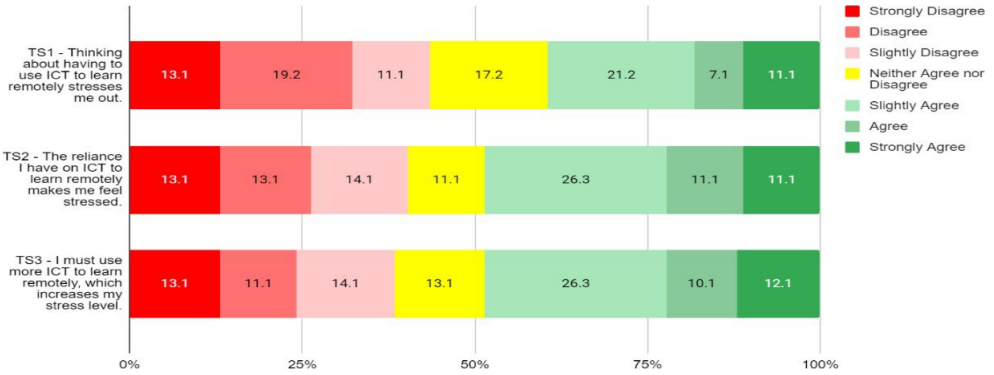

Figure 2: Technostress response distributions

In Figure 2, the response distributions are relatively even across the Likert scale. Because of this relatively even distribution, it explains why the mean for technostress (3.96) is so close to the expected mean of 4. However, this means that almost half of the students have experienced technostress to some degree, with more than 11% strongly agreeing to experiencing technostress. This supports the prominence of the phenomenon.

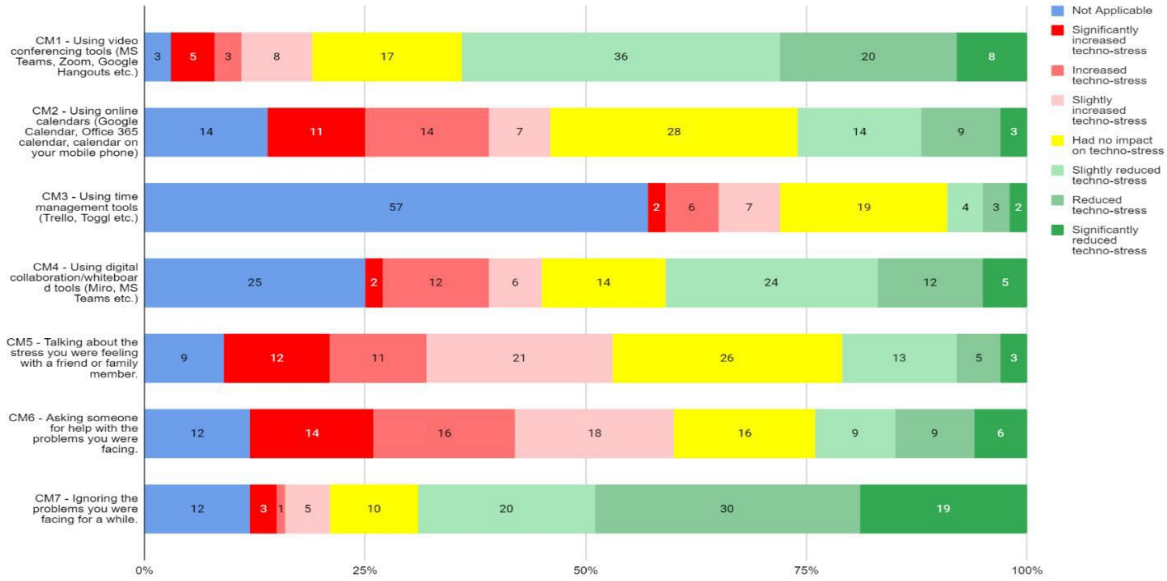

Figure 3: Coping Mechanisms response distributions

In Figure 3 above, the response distributions are not very consistent across all the questions for coping mechanisms, despite taking the "not applicable" responses into account. The "not applicable" responses were accounted for using a pairwise mean substitution for all the statistical analysis. CM1, CM2, CM4, and CM7 appear consistent, with more respondents agreeing with these coping mechanisms questions. However, CM3, CM5, and CM6 appear slightly more negative, compared to the skewness of CM1, CM2, CM4, and CM7. The difference in skewness between the questions shows that the factor is not very internally consistent in measuring the impact of coping mechanisms on students. In effect, coping mechanisms should not necessarily be seen as a single construct, but different coping mechanisms have

proved to be more useful or more widely adopted than others. E.g., time management tools were used far less than relying on friends or video conferencing tools. Perhaps surprising is that just letting things be – ignoring the problems for a while – was the most preferred and successful option.

Reliability and Validity Analysis

To assess the reliability of the model constructs, Cronbach Alpha values can be used. These values quantitatively indicate how internally consistent the factors are, looking at how related the questions within the factor are (Bhattacherjee, 2012; Saunders et al., 2012). According to Daud et al. (2018), a Cronbach Alpha lies between 0 and 1, and if the value is below 0.6, then the factor has low reliability. Ideally, the Cronbach Alpha value should be above 0.7 and if it is above 0,8 then it indicates even greater reliability (Daud et al., 2018). All the factors met the Cronbach Alpha threshold of 0.6 indicated by Daud et al. (2018). However, the techno-insecurity, techno-uncertainty, involvement facilitation, and remote learning experience factors (indicated in red) did not have a Cronbach Alpha value higher than 0.7. Because the desired value of each Cronbach Alpha is to be above 0.7, the reliability analysis was conducted a second time, seeing if removing one or more questions from the factor would increase the Cronbach Alpha value. The refined reliability analysis is shown in Table 1.

Factors that received a second analysis are shown in red. The table indicates what items were removed from the factor and the new Cronbach Alpha values for those respective factors. Removing TU3 and IF1 from their respective factors increased the Cronbach Alpha value to above 0.7, boosting the reliability of the factor. The second reliability analysis of Techno-insecurity (TI) and Remote learning environment (RL) revealed that no items could be removed to increase the Cronbach Alpha value to above 0.7. However, TI and RL were retained, because the factors still met the 0.6 threshold indicated by Daud et al. (2018). For the Literacy facilitation (LF) factor, LF3 was removed, while keeping the Cronbach Alpha value above 0.7. The reason for removing LF3 will be discussed below.

Table 1: Refined Reliability Analysis

Construct Name	Abbr.	Number of Items	Item removed	Cronbach alpha	Mean	Standard deviation
Techno-overload	TO	3		0.886	4.057	0.190
Techno-invasion	TI	3		0.795	5.193	0.261
Techno-complexity	TC	3		0.803	2.887	0.355
Techno-insecurity	TIS	2		0.653	3.020	0.424
Techno-uncertainty	TU	2	TU3	0.761	3.970	1.228
Literacy facilitation	LF	2	LF3	0.726	3.650	1.309
Technical support provision	TSP	3		0.888	4.200	0.084
Involvement facilitation	IF	2	IF1	0.845	3.000	1.296
Academic performance	AP	6		0.823	4.022	0.877
Technostress	TS	3		0.903	3.963	0.145
Digital literacy	DL	3		0.838	6.433	0.219
Remote learning environment	RL	3		0.686	3.815	0.815
Coping mechanisms	CM	7		0.754	4.281	0.592

An Exploratory Factor Analysis (EFA) was used to test the validity of the technostress model. EFA is a technique that takes a set of variables (for this research it was the questions from the questionnaire) and aggregates them into factors (Watson, 2017). These factors should ideally match the constructs in the theoretical model and account for collinearity between the initial variables (questions from the questionnaire) (Bhattacherjee, 2012). Stevens (2012) suggests a cut-off value of 0.5 for samples of 100. An

EFA was conducted the first time, with the TU3 and IF1 items removed, as per the reliability analysis shown in Table 1. The LF items did not load coherently on one factor, with LF3 being the problem. When a second EFA was conducted without LF3, after checking the Cronbach Alpha value for LF, the results of the second EFA were better. The results of the second EFA are shown in Table 2 below.

The following factors all loaded on a single factor with acceptable values: TU, TSP, IF, TS, DL, and RL. This result indicated that the factors were reliable and valid for regression analysis. TO and TI loaded on the same factor, indicating that the factors were correlated. Both factors were kept in the model as two semantically separate factors, TC and TIS also loaded on the same factor and were treated the same way as TO and TI. AP loaded on two separate factors. Reviewing the questions for AP revealed that AP1, AP2, and AP3 related to academic productivity, and AP4, AP5, and AP6 related to academic performance. These two groups of questions were then regrouped into Academic Productivity and Academic Performance. The questions for CM loaded on two factors. Reviewing the questions for CM revealed that CM1, CM2, and CM4 related to the use of digital collaboration tools, and CM3, CM5, CM6, and CM7 related to personal coping mechanisms. The factors where therefore regrouped into Digital Collaboration Tool Use and Personal Coping Mechanisms. The researcher chose to include CM2 and CM7 in their respective factors despite the value being below 0.5. The negative impact on factor reliability was noted.

Table 2: Model Exploratory Factor Analysis

Item	Factor												
	1	2	3	4	5	6	7	8	9	10	11	12	13
TO1	.803												
TO2	.875												
TO3	.839												
TI1	.726												
TI2	.587												
TI3	.544												
TC1		.513											
TC2		.743											
TC3		.804											
TIS1		.813											
TIS2		.524											
TU1			.752										
TU2			.869										
LF1				.819									
LF2				.476	.664								
TSP1					.839								
TSP2					.854								
TSP3					.860								
IF2						.683							
IF3						.736							
AP1							.855						
AP2							.846						
AP3							.717						
AP4								.747					
AP5								.682					
AP6								.759					
TS1									.779				
TS2									.774				
TS3									.711				
DL1										.779			
DL2										.846			
DL3										.835			
RL1											.726		
RL2											.759		
RL3											.672		
CM1												.816	
CM2												.448	
CM3													.724
CM4												.764	
CM5													.713
CM6												.412	.676
CM7													.493

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Rotation converged in 17 iterations.

Assessment of Technostress Model

Once the regrouping of factors was completed, the tests for relationships between the factors were conducted. First, a multiple linear regression was conducted with technostress as the dependent variable and Techno-Overload, Techno-Invasion, Techno-Complexity, Techno-Insecurity, Techno-Uncertainty,

Literacy Facilitation, Technical Support Provision, Involvement Facilitation, Digital Literacy, and Remote Learning as the independent variables. The results of the regression are shown in Table 3 below. The statistically significant coefficients at the 0.05 level are indicated with *.

Table 3: Multiple Linear Regression for Factors Influencing Technostress

	Unstandardized Coefficients		**Standardized Coefficients**	**t**	**Sig.**
	B	Std. Error	Beta		
(Constant)	4.360	1.866		2.336	0.022*
Techno-Overload	0.108	0.118	0.101	0.909	0.366
Techno-Invasion	0.181	0.133	0.150	1.357	0.178
Techno-Complexity	0.353	0.136	0.279	2.597	0.011*
Techno-Insecurity	0.006	0.112	0.005	0.052	0.959
Techno-Uncertainty	0.171	0.124	0.122	1.383	0.170
Literacy Facilitation	0.000	0.133	0.000	0.003	0.997
Technical Support Provision	-0.073	0.150	-0.051	-0.487	0.627
Involvement Facilitation	-0.258	0.130	-0.194	-1.975	0.051
Digital Literacy	-0.164	0.207	-0.076	-0.796	0.428
Remote Learning	-0.355	0.123	-0.255	-2.898	0.005*
a. Dependent Variable: Technostress					

The coefficients of Techno-Complexity and remote learning are statistically significant. This means that, if all other variables are held constant, a unit increase in Techno-Complexity will result in a 0.353 increase in the level of technostress. It also means that, if all other variables are held constant, a unit increase in the remote learning environment will result in a decrease in the level of technostress by 0.355. All the other factors did not have statistically significant coefficients, so no conclusions can be made about their relationships with technostress. It is worth noting that Involvement Facilitation is almost statistically significant at the 0.05 level.

Following the multiple linear regression, a linear regression was conducted with Academic Productivity as the dependent variable and Technostress as the independent variable. The results of the regression are shown in Table 4 below. All coefficients are statistically significant coefficients at the 0.05 level.

Table 4: Linear Regression for the Influence of Technostress on Academic Productivity

	Unstandardized Coefficients		**Standardized Coefficients**	**t**	**Sig.**
	B	Std. Error	Beta		
(Constant)	6.294	0.331		19.018	1.71E-34*
Technostress	-0.390	0.077	-0.460	-5.096	1.71E-06*
a. Dependent Variable: Academic Productivity					

The coefficient of Technostress is statistically significant at the 0.01. This means that a unit increase in technostress, will result in a decrease in academic productivity of 0.39.

For the next assessment, a linear regression was conducted with Academic Performance as the dependent variable and Technostress as the independent variable. The results of the regression are shown in Table 5

below. All coefficients are statistically significant coefficients at the 0.05 level. The coefficient of Technostress is statistically significant at the 0.01 level. This means that a unit increase in technostress, will result in a decrease in academic performance of 0.36.

The next test was for the moderating variables. The moderating effect of Digital Collaboration Tool Use Coping Mechanisms (DCTUCM) and Personal Coping Mechanisms (PCM) on both academic performance and academic productivity were tested. The first test has Academic Performance as the dependent variable and the second test has Academic Productivity as the dependent variable. The moderating effect was tested using Model 2 from Hayes (2017), which includes two moderating variables for a single relationship.

Table 5: Linear Regression for the Influence of Technostress on Academic Performance

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	4.735	0.335		14.116	2.97E-25*
Technostress	-0.364	0.078	-0.430	-4.691	8.89E-06*
a. Dependent Variable: Academic Performance					

The conditional effects of the moderators are all statistically significant, except for high DCTUCM and low PCM. The statistically significant results for the conditional effects indicates that DCTUCM and PCM do moderate the relationship between Technostress and Academic Performance, except when there is a high level of DCTUCM and low level of PCM. For the statistically significant moderation effects, at the respective DCTUCM and PCM levels, increasing the level of PCM will reduce technostress predicting academic performance.

Based on the changes made to the factors within the technostress model during the analysis, an updated technostress model was created. Academic Productivity has been added to the model, along with H13. Hypothesis 12 (H12) has been removed from the model and replaced by H14, H15, H16, and H17. The details for the new hypotheses are as follows:

- H13: There is a negative relationship between technostress and the academic productivity of students.
- H14: Personal Coping Mechanisms moderate the relationship between technostress and academic performance of students.
- H15: Digital Collaboration Tool Use moderates the relationship between technostress and academic performance of students.
- H16: Personal Coping Mechanisms moderate the relationship between technostress and Academic Productivity of students.
- H17: Digital Collaboration Tool Use moderates the relationship between technostress and Academic Productivity of students.

Findings

The findings section will discuss the hypotheses and if they are supported based on the data analysis. A summary of the hypotheses, their coefficients, p-Value, significance level, and an indication if they are supported is presented in Table 6 below.

Table 6: Hypothesis test summaries

Hypothesis	Coefficient	p-Value	Significance level	Supported?
H1	0.108	0.366	-	No
H2	0.181	0.178	-	No
H3	0.353	0.011	p<0.05	Yes
H4	0.006	0.959	-	No
H5	0.171	0.170	-	No
H6	-0.164	0.428	-	No
H7	-0.355	0.005	p<0.01	Yes
H8	-0.073	0.627	-	No
H9	0.000	0.997	-	No
H10	-0.258	0.051	-	No
H11	-0.364	8.89E-06	p<0.01	Yes
H12	Not tested due to revision of model			
H13	-0.390	1.71E-06	p<0.01	Yes
H14	Tested with conditional effects, so there is no singular coefficient			Yes
H15	Tested with conditional effects, so there is no singular coefficient			Yes
H16	Tested with conditional effects, so there is no singular coefficient			Yes
H17	Tested with conditional effects, so there is no singular coefficient			Yes

The revised technostress model is presented below in Figure 3. The coefficients from the regression tests have been added, with the statistically significant coefficients being indicated with an asterisk (*).

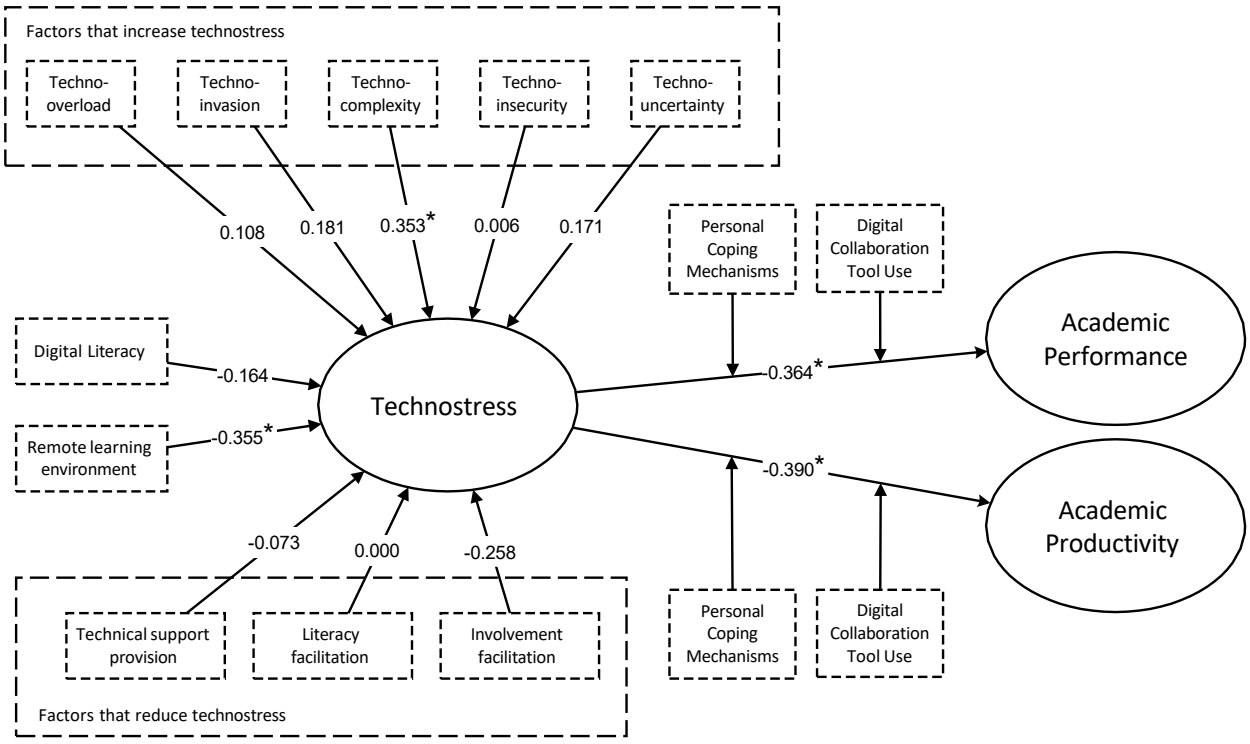

Figure 3: Revised Technostress Model with Coefficients

The findings of this model are not entirely consistent with existing literature. The factors that increase technostress are generally accepted to be techno-overload, techno-invasion, techno-complexity, techno-insecurity, and techno-uncertainty (Dragano & Lunau, 2020; La Torre et al., 2019; Srivastava et al., 2015; Tarafdar et al., 2015; Upadhyaya, 2021; Wang, K. et al., 2008). However, this paper found that only Techno-Complexity had a statistically significant, positive relationship with technostress. The factors listed in existing literature as those that reduce technostress are technical support provision, literacy facilitation, and involvement facilitation (Atanasoff & Venable, 2017). However, the findings of this paper did not include any of those factors as having a statistically significant, negative relationship with technostress.
The impact of coping mechanisms on the relationship between technostress and academic performance and productivity within this paper is consistent with literature. Personal coping mechanisms act as emotion-focused coping because it involves students finding ways to improve their emotional state to deal with the problem they are facing (technostress) (Salas et al., 2017). For digital collaboration tool use, it acts as a form of problem-focused coping because it involves the student confronting their technostress threat to resolve the situation they are in.

Discussion

The aim of this research was to analyse the impact of technostress on UCT students. This analysis was conducted using a technostress model and quantitative data analysis. Of the 16 hypotheses tested, eight yielded statistically significant results, which supported the respective hypotheses. The supported hypotheses revealed the following; there is a positive relationship between techno-complexity and technostress experienced by UCT students, there is a negative relationship between digital literacy and technostress experienced by UCT students, there is a negative relationship between technostress and student academic performance and productivity, and lastly, that the use of personal coping mechanisms and digital collaboration tools moderate the relationship between technostress and academic performance, and technostress and academic productivity.

These findings can be used to inform UCT about the importance of reducing techno-complexity and improving the remote learning environment of students. By addressing these two areas, the technostress levels of students can be reduced. By reducing the level of technostress in students, it can have a positive impact on UCT students' academic performance and productivity. Another factor to consider is the use of digital collaboration tools during remote learning. By effectively using these tools, the impact of technostress on academic performance and productivity can be reduced. UCT should also encourage students to use personal coping mechanisms like engaging with friends or family regarding their technostress level. As the research has shown, these coping mechanisms can reduce the negative impact of technostress on academic performance and productivity.

Interestingly, only one of the hypotheses regarding the factors that increase technostress was supported, and none of the hypotheses regarding the factors that reduce technostress were supported. This is not consistent with studies conducted by Upadhyaya (2021) and Ragu-Nathan et al. (2008). Further investigation into the student experiences of technostress is required to establish why. However, the inconsistency may be due to limitations of the research. The research was limited in its scope and target audience. The representativeness of the sample could have been improved by increasing the sample size and not using snowball (non-probability) sampling. The research was also limited by being cross-sectional due to time constraints. By analysing the sample at a single point in time, some factors of technostress could have been omitted from student responses. By using a questionnaire instead of interviews to gather the research data, some nuance and non-verbal cues from respondents could not be gathered.

Conclusions

The use of ICT has made the lives of many people better and will continue to do so. However, these benefits come at the cost of technostress, negatively impacting the health of many individuals who rely on ICT to work and learn. The impact of technostress has been analysed in organisational settings, but little research has been conducted in university settings, specifically in South Africa under remote learning conditions. This paper provided an analysis of the factors that increase and reduce technostress in the literature review, answering the first research question.

This paper has analysed the impact of technostress on UCT students and explained how technostress can negatively impact their academic performance and productivity. This analysis was conducted using quantitative data analysis (regression analysis), answering the second research question.

Within the research findings section of this paper, the similarities and inconsistencies between this paper's findings and existing literature were discussed. The main factors that increase technostress were not all statistically backed in the data analysis and none of the factors that reduce technostress were substantiated either. However, this paper has noted the consistency between its coping mechanism findings and existing literature. By discussing the various consistencies and inconsistencies between the findings and existing literature, the paper has answered the third research question.

This paper has contributed to the current research gap. The findings highlighted the importance of reducing techno-complexity for UCT students, working in good remote learning conditions, and using technical support when needed. The findings also revealed the need for students to effectively use digital collaboration tools and personal coping mechanisms, because they help reduce the impact of technostress on academic performance and productivity. By addressing these factors, UCT can reduce student technostress and improve their academic performance and productivity. Although some aspects of the data analysis did not have ideal reliability and validity, the findings of this research can potentially be generalised to other tertiary institutions. Because some of the findings from this paper are not consistent with existing literature, there is a need to explore this research area in greater detail, drawing more robust conclusions from further analysis.

Future research could assess the long-term changes in student technostress levels using a longitudinal study. The impact of returning to in-person learning should be analysed to see if it influences student technostress levels. Another recommendation is to extend the study to other universities to see if the model holds across institutional contexts. Finally, large sample sizes would likely increase the significance of relationships and narrow the confidence intervals for the various coefficients of the model.

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Appendix A

Model Component	Item Code	Question	N	Mean	Std. Dev.
Techno-overload	TO1	I am forced by ICT to work much faster	100	3.870	1.686
	TO2	I am forced by ICT to do more work than I can handle	100	4.250	1.743
	TO3	I am forced by ICT to work with very tight time schedules	100	4.050	1.930
Techno-invasion	TI1	I must be in touch with my work even during my vacation due to ICT.	100	5.490	1.679
	TI2	I must sacrifice my vacation and weekend time to keep current on new ICT.	100	5.090	1.724
	TI3	I feel my personal life is being invaded by ICT.	100	5.000	1.700
Techno-complexity	TC1	I need a long time to understand and use new ICT.	100	2.790	1.610
	TC2	I find my peers know more about ICT than I do.	100	3.280	1.787
	TC3	I often find it too complex for me to understand and use new ICT.	100	2.590	1.422
Techno-insecurity	TIS1	I don't share my ICT skills/knowledge with my classmates for fear of being ridiculed for a potential gap in my knowledge.	100	2.720	1.718
	TIS2	I feel there is less sharing of ICT skills and knowledge among classmates for fear of individuals being ridiculed for a gap in their knowledge.	100	3.320	1.769
Techno-uncertainty	TU1	There are always new developments in the technologies we use at UCT.	100	4.300	1.411
	TU2	There are constant changes in computer software at UCT.	100	3.640	1.337
	*TU3	I feel uncertain about what ICT I must use for remote learning.	100	2.870	1.488
Literacy Facilitation	LF1	UCT provides end-user training before the introduction of new technology.	99	3.485	1.388
	LF2	UCT fosters a good relationship between the IT department and end users.	100	3.830	1.570
	*LF3	UCT provides clear documentation to end-users on using new technologies.	100	3.970	1.439
Technical Support Provision	TSP1	UCT's end-user help desk is well staffed by knowledgeable individuals.	100	4.280	1.272
	TSP2	UCT's end-user help desk is easily accessible.	100	4.210	1.365
	TSP3	UCT's end-user help desk is responsive to end-user requests.	100	4.110	1.385
Involve-ment Facilitation	*IF1	UCT students are rewarded for using new technologies.	100	3.170	1.450
	IF2	UCT students are consulted before introduction of new technology.	100	3.020	1.435
	IF3	UCT students are involved in technology change and/or implementation.	100	2.980	1.363
Academic perform-ance	AP1	The ICT I use helps to improve the quality of my academic work.	100	4.890	1.470
	AP2	The ICT I use helps to improve my academic productivity.	99	4.768	1.677
	AP3	The ICT I use helps me to accomplish more academic work than would otherwise be possible.	99	4.596	1.702
	AP4	My academic performance improved under remote learning.	99	3.798	1.857
	AP5	Under remote learning, I feel more motivated to work.	98	2.724	1.692

Appendix A (Continued)

Model Component	Item Code	Question	N	Mean	Std. Dev.
Academic perform-ance	AP6	Under remote learning, it requires more effort for me to achieve the same results.	99	3.343	1.864
Techno-stress	TS1	Thinking about having to use ICT to learn remotely stresses me out.	99	3.798	1.884
	TS2	The reliance I have on ICT to learn remotely makes me feel stressed.	99	4.020	1.895
	TS3	I must use more ICT to learn remotely, which increases my stress level.	99	4.071	1.886
Digital Literacy	DL1	How would you rate your overall ability to use a computer's hardware (power on/off, use a keyboard and mouse/trackpad)?	98	6.561	0.800
	DL2	How would you rate your overall ability to use computer software (download, install, uninstall, navigate etc.)?	97	6.186	0.950
	DL3	How would you rate your overall ability to use the internet (search, use tabs, locate webpages in your search history etc.)?	97	6.515	0.831
Remote Learning Environ-ment	RL1	Privacy/availability of a workspace that is used by only you	99	4.131	1.536
	RL2	Access to learning resources and other course material	99	4.424	1.585
	RL3	Disruptions to your working environment (noise, additional responsibilities etc.)	99	2.889	1.622
Coping Mecha-nisms	CM1	Using video conferencing tools (MS Teams, Zoom, Google Hangouts etc.)	100	4.732	1.425
	CM2	Using online calendars (Google Calendar, Office 365 calendar, calendar on your mobile phone)	100	3.686	1.526
	CM3	Using time management tools (Trello, Toggl etc.)	100	3.791	0.905
	CM4	Using digital collaboration/whiteboard tools (eg Miro, Teams)	100	4.360	1.346
	CM5	Talking about the stress you were feeling with a friend or family member.	100	3.484	1.452
	CM6	Asking someone for help with the problems you were facing.	100	3.466	1.687
	CM7	Ignoring the problems you were facing for a while.	100	5.375	1.351