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Development Of Technostress Scale For Filipino Students Using Exploratory And Confirmatory Factor Analysis

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Abstract

This study aimed to develop and validate a Technostress scale for Filipino students using development and research method. Items in the scale were constructed through interviews with purposively selected tertiary students and were subjected to validation by experts. Results showed a high level of content and face validity. Exploratory Factor Analysis showed five misfits of the scale: abilities-demands of technology, abilities-demands of a school requirement, person-people, needs-supplies of technology, and needs-supplies of the school. In addition, Confirmatory Factor Analysis indicated that the model of the scale has an acceptable fit. The convergent and discriminant validity results revealed that the scale exhibits psychometric quality, and the items reliably measure their corresponding constructs. Based on the reliability index, the questionnaire could yield the same results even after multiple trials. Therefore, educators can use the developed technostress scale to diagnose students with problems adjusting to a technology-based learning environment.

Keywords: confirmatory factor analysis, exploratory factor analysis, technostress, COVID-19 pandemic, technology

1. Introduction

The COVID-19 pandemic has significantly disrupted different educational systems around the world. Educational institutions have been temporarily closed in most countries worldwide, and over 90 percent or more than 1.5 billion students and youth of the world's student population are affected by this closure nationwide (Tarker,

2020; Global Education Coalition, 2022). With the challenges brought by the pandemic, countries like China, the USA, India, and Pakistan promoted seamless education (Jena, 2020) through distance learning (Tadesse & Muluye, 2020), online teaching, and virtual education (Daniel, 2020) like the use online learning management system (Maqsood et al., 2021) as a solution to continue the education system.

Like other countries, the Philippine educational system has also drastically shifted from traditional face-to-face classes to flexible learning modalities since the beginning of the COVID-19 pandemic (Agaton & Cueto, 2021). Modular teaching and learning, distance learning, and blended learning are the modalities that replaced traditional face-to-face classes in the country (Verde & Valero, 2021). Teachers were required to modify the course syllabi to suit the needs of the changing time. However, students and teachers needed electronic gadgets and reliable internet connections to access the various learning management systems. With the acceleration and presence of information and communication technologies (ICTs), it is becoming imperative for individuals to engage with these technologies to get work accomplished constantly (Ayyagari et al., 2011). It enables them to access educational resources, connect with friends and peers, and utilize it for entertainment (Paguirigan & Paguirigan, 2022).

In the Philippines, students and teachers face significant obstacles in terms of internet access and the availability of electronic devices (Asio et al., 2021). To adapt, many teachers have also ventured into utilizing these tools for online learning delivery modes. However, their confidence in using these technologies remains limited because of their insufficient understanding of learning management systems (Cadorna et al., 2022). While new technological advancements offer potential benefits for students, they can also lead to academic stress and other school-related pressures (Raja Zirwatul Aida et al., 2007), contributing to increased stress levels overall (Ayyagari et al., 2011). One particular form of stress that arises is known as technostress, characterized by negative psychological effects linked to the use of information and communication technology (ICT) or the perceived threat of its future use. This stress stems from a perceived imbalance between the demands and resources associated with ICT, resulting in heightened negative psychological and physiological reactions and a negative attitude towards technology (Salanova et al., 2013). Furthermore, technostress signifies the challenge individuals face when they struggle to adapt to and manage technological demands (Nimrod, 2018; Tarafdar et al., 2007). Students encounter stress

when they struggle to effectively integrate information technologies into their lives (Tarafdar et al., 2007).

Technostress scales have been developed in education, emphasizing students and teachers. These scales were not constructed in the context of Filipino culture. The culture of the students in the development of scales needs to be considered because there is a need to consider diverse study populations in terms of digital literacy and cultural backgrounds (Nimrod, 2018).

With this premise, there is a need to develop a technostress scale for Filipino learners, considering the culture and sample size in the Philippines, since stress like technostress is culturally different (Pourmand et al., 2021; Lee et al., 2023). Upadhyaya and Vrinda (2020) mentioned that technostress among students might lead to a higher burden on higher education institutions through decreased productivity, drop-outs, and deviation from academic work. Developing a technostress scale for students could help educators understand the students' psychological well-being in association with the use of technology and help them devise strategies to increase students' participation in a technology-based learning environment (Wang et al., 2020).

Research Objectives

This study aimed to construct a technostress scale (TSS) for students. Specifically, it sought to: (1) develop a technostress scale for students, (2) validate the technostress scale for students, (3) explore the constructs of the validated technostress scale, and (4) confirm the factor model.

Literature Review

Nimrod (2018) and Tarafdar et al. (2007) defined technostress as a problem of adaptation experienced by individuals when they cannot cope with challenges associated with the use of technology. This study aims to develop a technostress scale to understand university students' psychological well-being using information and communication technologies (ICTs). Therefore, this study is anchored on the Person-Environment fit theory, which focuses on the interaction between the characteristics of the individual and the environment. It means that the individual influences not only the environment, but the environment also impacts the individual (Holmbeck et al., 2008). When there is an absence of adjustment between the person and the environment, there is no equilibrium between the two, thus resulting in stress. In other words, there is a misfit. The "person" in the P-E Fit theory in this research refers to the tertiary education students of the Province of Ilocos Sur. The

"environment" will be the mode of delivery during online learning sessions.

Technostress scales have been developed in education, emphasizing students and teachers. Wang and Li (2019) investigated the phenomenon of technostress among Chinese university teachers using the Person-Environment misfit framework. They concluded that using ICT and the suitability of ICT both affect the job performance of teachers.

Wang et al. (2020) developed a technostress scale for university students in China using the Person-Environment (P-E) fit theory. They identified abilities-demands misfit and needs-supplies misfit as constructs of their study. Further, they asserted that developing and validating a technostress scale is vital for diagnosing students who could have problems adjusting to a technology-based learning environment. Abilleira et al. (2021), on the other hand, validated a technostress scale for Spanish university students based on a scale that has been designed for Chinese students. Five constructs were identified in this study, consistent with Wang and Li (2019).

Moreover, Vega-Muñoz et al. (2022) validated a scale to measure the technostress level of Chilean students under the context of hybrid education. Abilities-Demands Techno-Educational (ADTE), Needs-Supplies Resources (NSR), and Person-People Factor (PPF) were the identified constructs to measure the technostress level of Chilean students.

Although these scales were developed using the Person-Environment Fit theory, they were not constructed in the context of Filipino culture.

2. Methodology

The study utilized the research and development method. The research phase of the study includes interviewing the respondents regarding how technology gives them stress in their schooling. The development phase includes generating items through the gathered responses. The study's respondents included 1333 tertiary students of the state colleges and universities in Ilocos Sur.

Exploratory Factor Analysis (EFA) and Confirmatory factor Analysis (CFA) were used as tools for the scale development (Orcan, 2018; Flora & Flake, 2017; Khan et al., 2022; Willmer et al., 2019; Riboroso, 2021).

There were three stages in the study. The first stage was the development and validation of the Technostress scale. The items were constructed based on the interview results from 23 students chosen through purposive sampling. A semi-structured interview was used to gather responses from the interview. The constructed items underwent content and face validation by two psychometricians and one technology expert.

The second stage was the Exploratory Factor Analysis (EFA). Eight hundred ninety-nine students from a state university in the northern Philippines participated in the EFA. The final stage of the study was the confirmation of the item constructs from the results of EFA using the Confirmatory Factor Analysis. This stage involved 411 students from the three state universities in Ilocos Sur. Responses for both the EFA and CFA were gathered through google forms.

The items on the technostress scale were based on the student's responses during the first stage of the study. The items were in Likert-scale type (5 - Always, 4 - Often, 3 - Undecided, 2 - Rarely, 1 - Never). Each item of the developed technostress scale underwent validation using a Likert scale using the following norms: 4 - Very Relevant, 3 – Relevant but needs minor revision, 2 – Item needs revision, 1 – Not relevant. The mean score was used to assess the content validity of the developed technostress scale. Experts assessed the face validity of the scale through comments and suggestions during the validation process. The Kaiser-Meyer-Olkin measure of sampling adequacy was used to ensure enough responses for further analysis. In addition, Barlett's Test of Sphericity, a prerequisite for factor analysis to work, was used to determine if the correlation matrix has significant correlations.

Factor loadings were used to determine which items would be retained in the Exploratory factor analysis. In this stage, factor loadings that are less than four (4) were suppressed (Field, 2013). The fitness of the model in the confirmatory factor analysis was evaluated using the following norms: acceptable fit when CMIN/DF value ≤ 3 (Kline, 1998); acceptable fit when GFI and TLI are ≥ 0.90 (Hu & Bentler, 1998); acceptable fit when CFI $\geq$ is 0.90 (West et al., 1992); reasonable fit when RMSEA is ≤ 0.05 (MacCallum et al., 1996); acceptable fit when NFI ≥ 0.90 (Byrne, 1994); and acceptable fit when SRMR is ≤ 0.05 (Diamantopoulos & Siguaw, 2000).

To observe ethical considerations in the study, the researchers provided informed consent for the respondents, assuring their names' anonymity. The researchers aimed to develop and validate a Technostress Scale for Filipino students. There was no conflict of interest found in the study. The data gathered were saved on a laptop with a password only known by one researcher and was deleted after the completion of the study. The terms and conditions of the study were also put in the Informed Consent Form. The rights of the participant evaluators were included in the form.

3. Results

3.1. Development of Items in the Technostress Scale

Verbatim transcription was used to determine the items included in the technostress scale. The inductive method was used to generate the pool of items for the scale. In an inductive method, the items are based on qualitative information gathered from target respondents (Kapuscinski & Masters, 2010). Extracts from the interview were used to the development the items in the technostress scale. The questions in the semi-structured interview asked about situations where the students felt stressed regarding the use of technology. All questions were contextualized on the use of educational technologies during online classes.

3.2 Validation of the Technostress Scale

Content validation by experts followed this step. The experts commented that the researchers must group the items accordingly to achieve a better understanding when subjected to pilot testing. However, the researchers explained that the items would be factored in during the study's second phase. The content validation of the experts obtained a mean rating of 3.40, which means that the items in the scale are relevant, and the constructs represent items that could measure the technostress of the learners. The experts also noted some revisions in the construction of the items, such as using "study area" instead of "workplace" and using the word "tensed" instead of "pressured and nervous." The experts also suggested contextualizing the items such as using "school requirements" instead of "requirements" and "academic life" instead of "life." The item in the original scale, "I lose track of how much time I spend using technology to do my projects." was revised to "I feel overwhelmed about the time I spend using technology to do my school projects." Another item, "I feel that technology is complicated, and I cannot catch up with it." was revised to "I feel that technology discomposes my study sessions." The item "I feel pressured and

nervous in doing my requirement because I am not a technology expert" was revised to "I feel tensed in doing my school requirements that require the use of technology due to lack of expertise." The item "I need a long time to understand and use new technologies" was revised to "I am burdened with spending too much time understanding and using technologies." Lastly, "I do not find enough time to understand and use new technology" was revised to "I am constrained by time to learn and upgrade my technological skills."

3.3 Exploratory Factor Analysis

The developed scale underwent exploratory factor analysis to test whether or not the components conform with the existing scales. Varimax rotation and eigenvalues greater than one were considered to determine the constructs of the scale (Gol et al., 2020; Carpenter, 2018; Majmundar et al., 2018).

The Kaiser-Meyer-Olkin measure of sampling adequacy (p=.978) indicates that the study has enough samples to proceed with the analysis. Moreover, Barlett's Test of Sphericity $(\chi^2 = 30235.696, \mathrm{df} = 741, \mathrm{p} - \mathrm{value} = .000)$ shows that the correlation matrix is an identity matrix and that not all groups have the same variance, with a total explained variance percentage of 60.830%.

Table 1. Exploratory Factor Analysis based on eigenvalues greater than 1

Items		Component				
		1	2	3	4	5
23	I feel frustrated when I am unable to use the technological tools properly because I do not know how to operate them.	.700				
28	I feel embarrassed when others are watching me because I do not know much about the technology we use in school.	.693				
13	I feel pressured when teachers urge us to use technologies with which I am unfamiliar.	.662				
26	I feel tensed in doing my school requirements that require the use of technology due to lack of expertise.	.649				
11	I feel lost in my studies when I do not know how to use technology.	.648				
25	I feel left behind because my peers are more advanced in using technology.	.631				

15	I am forced to deal with the demands of technology though my skills are inadequate.	.626		
22	I feel that my abilities do not fit on how fast technology emerges and updates.	.588		
24	I find it difficult to do activities that require video editing tools.	.584		
27	I feel that I am becoming less excellent in my studies because I lack skills on the technology we use in learning.	.552		
10	I lose motivation in doing school requirements because of the pressure of using technology.	.546		
29	I often find it too complex for me to understand and use new technology.	.540		
35	I feel pressured to do better in using technology around digitally literate people.	.537		
14	I feel irritated because of the invasion of technology in my studies.	.523		
12	I feel anxious because learning through technology alone is not helping me advance my studies.	.474		
4	I am not comfortable using technology the whole day to make my school requirements.		.704	
2	I feel stressed with the rise of new technology that is required for my studies.		.680	
5	I feel pressured to prepare my study area with the use of technology.		.679	
6	I struggle in learning new technology from time to time.		.617	
7	I am not comfortable realizing that technology already rules my academic life.		.609	
1	I find it difficult to keep up with technological advancements.		.572	
9	I feel that technology discomposes my study sessions.		.516	
8	I feel overwhelmed about the time I spend using technology to do my school projects.		.451	
32	I do not get any help at home with regard to the use of technology because most of my family members are from a different generation.			.723
30	I do not have a team to collaborate with to use technology in my studies.			.652
31	I feel pressured because my family has high expectations on me as regards the use of technology required in my studies.			.608

33	I am burdened to spend too much time understanding and using technologies.			.539		
34	I am constrained by time to learn and upgrade my technological skills.			.515		
36	I am pressured to change my current learning habit and preference to meet the requirement of technology-enhanced learning.			.496		
37	I feel alone when exploring new technology needed in my studies.			.489		
38	I feel exhausted because my devices do not conform to the current updates of technology.			.483		
17	I am less willing to use technology in learning practical skills in my course.				.668	
19	I feel that using technology is a hindrance to my success in learning.				.627	
18	I feel like I need to work quickly every time because of technology.				.554	
21	I feel anxious when my computer and/or other devices encounter technical issues.					.845
16	I believe that technology with poor internet connectivity gives me more problems.					.796
20	I find submitting school requirements stressful because of poor internet connection.					.740
3	I feel anxious when my devices lag due to internet connection.					.629
	% of variance	45.418	5.935	3.967	2.887	2.623
	Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.					

a. Rotation converged in 7 iterations.

Table 1 presents the result of the factor analysis, which shows a five-factor solution corresponding to the model proposed by Wang and Li (2019). There are 15 items for Factor 1, eight (8) items for Factor 2, eight (8) items for Factor 3, three (3) items for Factor 4, and four (4) items for Factor 5.

The first factor of the developed scale pertains to the misfit between the student's abilities and technology demands (ADT). The items in this factor pertain to how the students struggle in dealing with what technology demands them to do and to be despite their lacking abilities in learning the technology used in school.

The second factor highlights the imbalance between their abilities and the demands of the school in using technology (ADS). This factor talks about how technology demands students to adjust to the needs of their academic careers as prescribed by the school.

The third factor pertains to the misfit between the students and those surrounding them (person-person misfit or PPF). This factor points out how the students struggle with technology with the expectations of the people around them and even without someone to help them learn the demands of technology.

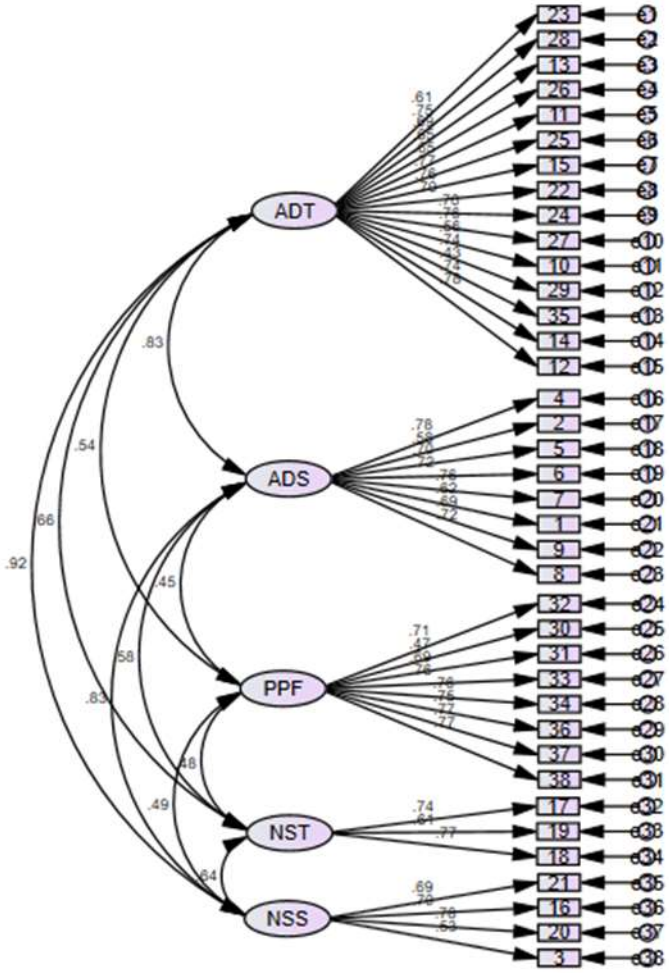
The fourth factor (NSS) is about the non-conformity of technology used in the school to achieve the desired outcomes in their courses.

Lastly, the fifth factor (NST) deals with the problems encountered by the students when submitting school requirements. This factor pertains to how their technological needs and supplies misfit with their school productivity level.

3.4 Confirmatory Factor Analysis

Confirmatory Factor Analysis was applied to validate the factor model. According to Randall and Jung (2018), Confirmatory Factor Analysis (CFA) represents a distinct form of factor analysis designed to assess the degree of the hypothesized association between observed indicators and underlying latent variables, commonly referred to as factors. Furthermore, CFA facilitates the differentiation between these latent factors and the indicators (variables) employed to measure these latent constructs. Figure 2 shows that the initial model did not meet the established criteria for a model fit. Hence, the model must be revised to obtain acceptable fit indices. Modification indices were considered, and constructs with standard residual covariances greater than two were deleted to obtain a model fit (Hamilton & Tee, 2015).

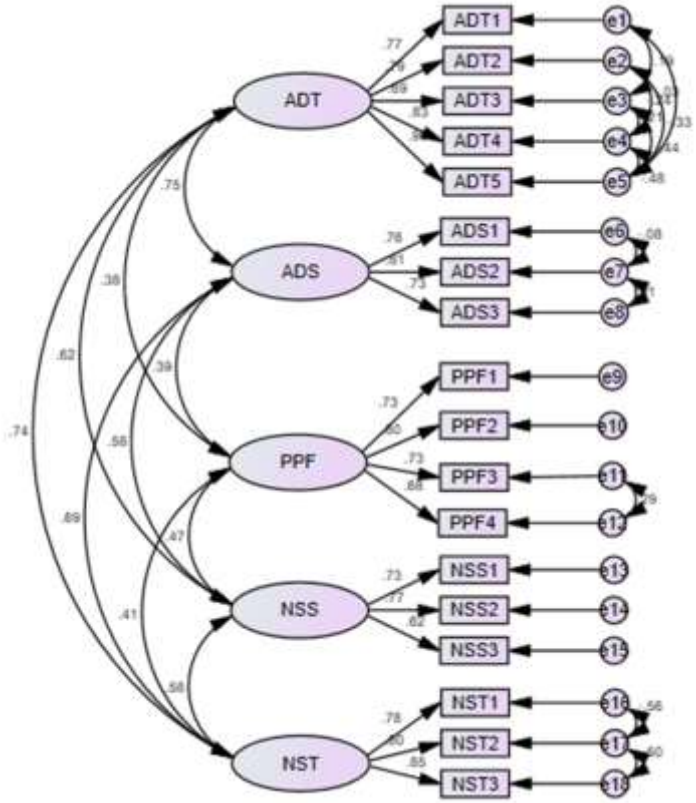
Figure 1. Initial Model of the Scale



CMIN/DF=3.034, p=.000, GFI=.703, NFI=.666, TLI=.727, CFI=.746, RMSEA=.098, SRMR=.0979.

After modifying the indices and item deletion through the standard residual covariances, only 18 items were retained. The final model shown in Figure 3 obtained an acceptable fit for GFI (Hu & Bentler, 1998) and NFI (Byrne, 1994). On the other hand, the model obtained an excellent fit for TLI (Hu & Bentler, 1998) and CFI West et al. (2012). Moreover, the RMSEA of the model has a reasonable fit (MacCallum et al., 1996), and the SRMR obtained an acceptable fit (Diamantopoulos & Siguaw (2000). The final model of the scale contained five (5) items for ADT, three (4) items for ADO, four (4) items for PPF, three (3) items for NSO, and four (4) items for NST.

Figure 2. Final Model of the Scale



CMIN/DF=1.229, p=.000, GFI=.936, NFI=.929, TLI=.981, CFI=.986, RMSEA=.033, SRMR=.0396

Composite reliability and average variance extracted (AVE) were used to assess the convergent validity of the scale. These measure the internal consistency in scale items and the amount of variance taken by a construct about the amount of variance due to measurement error, respectively (Shrestha, 2021). On the other hand, maximum shared variance (MSV) and average shared variance (ASV) assessed its discriminant validity (Chandel, 2015). Results are shown in Table 2.

A composite reliability of 0.70 or more (Hair,1997) is needed to ensure the internal consistency of the items. Moreover, to determine, on average, how many variations in each item can be explained by the construct or the latent variable, Fornell and Larcker (1981) recommended an AVE greater than 0.5. Results also reveal that both MSV and ASV are less than the AVE. The reliability test measured the internal consistency of the model using Cronbach Alpha. Analysis shows that the reliability index of the model is 0.913.

This study sought to develop and validate a technostress scale for Filipino students. The items in the scale constructed through

interviews were subjected to validation, and the results show that the constructs are clear and measure what they intend to measure. Moreover, the exploratory factor analysis results showed that there are indeed misfits between the person and the environment, which in this study refers to technology.

Table 2. Convergent and Discriminant validity of the developed scale

Construct	Item	Factor Loadings	CR	AVE	MSV	ASV
Abilities-Demands (Technology)	I feel lost in my studies when I do not know how to use technology.	.899	.897	0.637	.566	.411
	I am forced to deal with the demands of technology though my skills are inadequate.	.828				
	I feel that my abilities do not fit on how fast technology emerges and updates.	.687				
	I feel irritated because of the invasion of technology in my studies.	.792				
	I often find it too complex for me to understand and use new technology.	.768				
Abilities-Demands (School)	I struggle in learning new technology we use in school from time to time.	.759	.810	.587	.566	.384
	I am not comfortable realizing that technology already rules my academic life.	.809				
	I feel that technology discomposes my study sessions.	.728				
	I do not get any help at home with regard to the use of technology because most of my family members are from a different generation.	.725	.824	0.541	.226	.173

Person-People	I do not have a team to collaborate with to use technology in my studies.	.800				
	I feel pressured because my family has high expectations on me as regards the use of technology required in my studies.	.728				
	I feel alone when exploring new technology needed in my studies.	.683				
Needs-Supplies (Technology)	I am less willing to use technology in learning practical skills in my course.	.734	.752	.505	.383	.321
	I feel that using technology is a hindrance to my success in learning.	.770				
	I feel like I need to work quickly every time because of technology.	.618				
Needs-Supplies (School)	I feel anxious when my computer and/or other devices encounter technical issues.	.778	.849	.653	.554	.387
	I believe that technology with poor internet connectivity gives me more problems.	.797				
	I find submitting school requirements stressful because of poor internet connection.	.847				

Similar to the study of Wang & Li (2019), the misfits identified in this study are students' abilities to the demands of the university, students' abilities to the demands of technology, the needs of the students, and the resources the university is providing; needs of the person and the available technological resources; and the misfit between the interpersonal factors surrounding the student. Confirmatory factor analysis, on the other hand, confirms the fitness of the developed scale. Hence, the scale can be used to assess the

technostress level of the students, whether in online, face-to-face, or blended learning.

The internal consistency reliability obtained from the final model means that the items in the scale agree with each other. Results reveal that ADT, ADS, PPF, and NSS items have good alignments with reliability coefficients greater than 0.80. On the other hand, items in the NST construct have fair alignments with a reliability coefficient of 0.752. The results indicate that all factors on the test relate to all other factors (Hajjar, 2018). The average varianceS extracted in each construct, which are all greater than 0.5 (Fornell & Larcker, 1981), confirms the convergent validity of the model.

The values of the MSV and ASV that are less than the AVE (Hair et al., 2014) indicate the discriminant validity of the model. These results imply that all the measures have psychometric quality, and the items reliably measure their corresponding constructs (Adedeji et al., 2017). Lastly, the reliability index means the instrument could yield the same results over multiple trials.

4. Conclusions and Recommendation

The developed items in the technostress show that Filipino students experience stress when using educational technologies during their online classes. The items in the scale are clear and relevant to the concept it intends to measure. Responses imply an imbalance between students' abilities, technology, and environment. These results are strengthened by the exploratory factor analysis showing the existence of misfits between the learners' abilities, technology, environment, and supplies. On the other hand, the confirmatory factor analysis confirmed that the five factors of the developed technostress scale obtained an acceptable fit. Indeed, the scale can be used as a tool to assess the technostress levels of students.

The respondents in the scale development involved tertiary students in a public university in the northern Philippines. Future studies could consider more students from public and private universities across the province to determine if other constructs can be explored through their responses. Educators can use the validated scale to assess the technostress level of tertiary students.

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