Investigating the Impact of Technostress on Perceived Hybrid Learning Environment and Academic Performance

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Abstract: For the betterment of society, education plays a significant role in helping human beings in both tangible and intangible manner. From time to time, various transformations came to the teaching and learning pedagogy. Moreover, it has been evaluated by respective available resources. During and post-COVID-19, we have seen a considerable inclination towards hybrid learning. So, as a researcher, we also need to evaluate whether it has been progressing well. The emergence of different waves of pandemics across the globe has forced higher education institutes to develop and implement new educational models and policies that help to improve the quality of education and learning. However, we also need to examine the impact of these new modalities. For this, Tecnologico de Monterrey, Mexico, has also implemented its novel hybrid educational model, ' HyFlex+Tec,' to continue and uplift academic activities. This model has proposed access to quality education during and post-pandemic crisis and offers the possibility of providing a more environmentally friendly educational model. This study aims to explore the role of technostress in the association between a hybrid learning environment and students' academic performance and to reflect on how this new mode of blended learning could promote 'green-based' learning in an era of climate emergency. For this, we deployed a Form-based online survey among students through the convenient sampling technique. In total, we received 94 registered responses. For statistical analysis of quantitative datasets, we used a free and open statistical application, i.e., Jamovi. After the regression-based examination, it has been noted that technostress fully mediates the relationship between the perceived hybrid learning environment and the academic performance of undergraduate students. The reason for the occurrence of technostress among students is the continuous change in modalities, where the adaptation of new digital tools (software and devices) in a short time affects academic performance, thereby causing a lack of participation in course activities. This research provides guidelines to the university and government policymakers to update or introduce new flexible degree programs (in-person and hybrid) to promote digital skills and the wellbeing of students.

Keywords: Educational innovation, e-Learning, Hybrid learning, HyFlex+Tec, COVID-19, Institutional policy

1. Introduction

During the emergence of COVID-19, the transition of in-person to online learning, and then post-shifting to hybrid learning, this disruption is compelling policymakers to conceive fresh strategies to enhance student engagement, ensure all-encompassing digital learning setups, and surmount the challenges inherent in this transition. In 2015, the United Nations set an agenda for the vision of 2030 and proposed 17 sustainable development goals (SDGs). SDG-4 is based on education to improve the quality of education at all levels. The last few years have witnessed how the COVID-19 pandemic affected global education. School closures occurred because of the pandemic; consequently, 86% of students were affected, with 147 million children unable to attend school and in-person classes (Abbas *et al.*, 2024; UN, 2022; UNESCO, 2022). The impact of COVID was significant on students' learning, such as their change in emotions during the online e-learning classes, and this leads to behavioral changes that are analyzed by AI-based deep learning models (Bhardwaj *et al.*, 2021; Bhaik *et al.*, 2022). In academia, e-learning is not a new concept; it happened before COVID-19 but got attention during COVID-19 due to continuing education and reduced learning loss due to the pandemic. During the pandemic, educational institutions, significantly higher education institutes (HEIs), initiated steps toward the continuation of education through online teaching (i.e., emergency remote teaching) (Portillo *et al.*, 2020). Rapidly transforming the mode of education from in-person to online learning negatively affects the objectives of educational activities regarding course content and academic performance (Hafeez, Naureen and Sultan, 2022; Sastre-Merino *et al.*, 2020). According to Martín-Núñez *et al.* (2022), the drawbacks of emergency remote teaching are a lack of interpersonal contact and adaptability. In a contrary study, Mexican private university

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students already have experienced digital adoption in terms of familiarity with digital resources (Aguilera-Hermida *et al.*, 2021).

During different waves of COVID-19, all HEIs closely monitored pandemic scenarios and government educational policies. Based on the latest pandemic scenario and national and international educational policies, most HEIs developed and adapted new educational approaches and models to continue academic activities. For example, all educational activities were halted during the first quarter 2020. Then, steadily, with time, academic activities were held online (i.e., e-learning). These policies and modalities impacted teachers', students', and parents' performance and emotions (Rodríguez-Galván *et al.*, 2022). The rapid change in the learning process (Wasif, Munir and Shad, 2011), which heavily relies on digital technologies, has led to several effects. Most noticeable is that the educational transformation to digital learning burdened learners (Iivari, Sharma and Ventä-Olkkonen, 2020). On the contrary, perceived advantages encompassed establishing a digital learning community, enhancing students' proficiency in digital learning, and maintaining connections during challenging periods (Li, 2022).

The COVID-19 pandemic significantly influenced the adoption of hybrid learning. It is worth noting, however, that distance education has been present since the 1700s, as Harting (2005) reported, citing the development of the correspondence school model, which subsequently progressed with integrating innovative technologies and resources. The introduction of the personal computer and, more specifically, the internet and related technologies have facilitated the proliferation and mass adoption of distance learning (Harting, 2005; Moore and Kearsley, 2011). Over the years, several authors have analyzed both the advantages and disadvantages of online and blended learning approaches for students and learners. O' Shea, Stone and Delahunty (2015) outlined the benefits of virtual learning, including the option to engage online and the flexibility and independence provided by web-based instruction. The authors report that despite being "virtual" students, they still experience a sense of community on their college campus due to a supportive learning atmosphere.

Nonetheless, several authors have also discussed different challenges blended and online learning models impose. Kozma (1994) identified the technological challenges learners face due to the rapid evolution of tools and software, which could lead to frustration in the learning process. Since the widespread adoption of blended and online learning content, researchers have tried to understand the benefits and challenges of this learning model. Song, *et al.* (2004) identified that some challenges for online learning were the lack of sense of community, time management by learners for online courses, confusion about course objectives and information overload, communication and assessment barriers and challenges, and students' different levels of digital literacy.

After the pandemic, things are moving toward normalization. The hybrid educational model is still a milestone toward normalizing and continuing educational activities. This model allows students to start their in-person academic activities partially. This model is also technology-driven, with in-person or online learning options. Several studies highlight that the change in the mode of education during COVID-19 (Samawi and Al-kreimeen, 2022) affected students' academic performance. Other reasons for technostress are adaptation to digital tools in a short time of isolation with no physical interaction with peers and teachers.

As a step toward normalization, Tecnologico de Monterrey (TEC) developed and implemented a new hybrid educational model called HyFlex+Tec (Abbas, Martín-Núñez and Iqbal, 2022; Galvis and Carvajal, 2022). After implementing the HyFlex+Tec educational model, the Tecnologico de Monterrey became the first HEI in Mexico to partially start in-person educational activities (Rodriguez-Paz *et al.*, 2021). HyFlex+Tec is based on a hybrid learning environment, offering students options for in-person and online degree courses (Lin, 2021). The concept of HyFlex+Tec is to invite professors to physically come to the classroom and give lectures using multimedia tools; 50% of students physically attend the talks, whereas the remaining 50% attend online (Ward, 2004). On a weekly rotation basis, students take their in-person or online classes. In this new hybrid learning environment, students continue their course activities.

Implementing blended learning education allows higher education institutions to take action towards environmental sustainability. Hall and Mooney (2010) state that the inefficient use of fossil fuels in commuting to campus and in the production and distribution of printed materials associated with face-to-face education provides a valuable argument for the sustainability of the hybrid education model.

1.1 Objective of the Study

This study aims to empirically explore students' opinions about the role of technostress in the relationship between the perceived hybrid learning environment and academic performance. We deployed an online survey

among Tecnologico de Monterrey undergraduate students in Mexico to achieve this objective. After data collection, we statistically analyzed quantitative data using open-source Jamovi software to test all proposed hypotheses and draw conclusions.

2. Background

The online learning concept is not new; it has been implemented in educational settings for decades (Harasim, 2000). The purpose of this was to promote education at all levels. The concept of hybrid education was initially started in the 1970s and 1980s, when firms trained their employees using video, and questions were sent to the instructor through email. Later, in academics, the concept of hybrid learning was introduced by Stanford University Interactive TV network to deliver Professors sessions, and students submit their work online for review. Later, in the 1980s and 1990s, the mode of instruction was transformed to digital media, where recorded video lectures were stored on CD-ROMs.

Meanwhile, Learning Management Systems (LMS) were introduced and implemented in the HEIs to manage and promote educational activities such as course registration, material, discussion, and so on (Tritsch, 2021). In 1998, web-based instructions were introduced, and all course materials were available online. Since 2000, the hybrid learning environment has continuously emerged and is considered flexible regarding availability (Güzer and Caner, 2014). The new term adopted for hybrid learning is HyFlex, where offered courses provide opportunities for both online and face-to-face, the medium of instruction to the students where traditional flipped classrooms were not providing flexibility (Binnewies and Wang, 2019). The concept of the HyFlex mode is to encourage students to engage and continue their education during the pandemic (Miller, Sellnow and Strawser, 2020).

The critical contributions of the paper are as follows:

- Evaluating the Hybrid learning model, post-pandemic.
- Identifying the technostress as a risk factor in hybrid learning.
- Analysis reveals that academicians and students suffer from emotional and mental stress.
- Academicians/students prefer to interact in person rather than online or hybrid.

3. Relevant Literature Review and Hypotheses Development

3.1 Perceived Hybrid Learning Environment

Education continues to go through different transformation stages after the pandemic crisis. Most of the HEIs around the world are now implementing the hybrid model. The hybrid education model provides students a hybrid learning environment combining physical and digital interactive environments to enhance engagement and promote shared learning during classes (Cook and Holley, 2022). The hybrid learning environment primarily combines in-person and online modalities that provide a meaningful learning experience and is considered less complicated (Bozkurt, 2022; Mcdonagh, 2023) than the online or in-person educational model. Hybrid learning offers a study environment with an active engagement approach to get better outcomes by utilizing computers and the internet. However, the abrupt introduction of remote education due to the COVID-19 pandemic created anxiety among students due to their unfamiliarity with new software, as well as among educators regarding how to manage lecture activities (O'Ceallaigh, Connolly, and O Brien, 2023; Rosi, Abdurrahman and Wahyuni, 2022). Hodges, *et al.* (2020) note that the rapid shift from in-person classes to entirely online or hybrid models in response to disruptive events should be referred to as Emergency Remote Teaching (ERT), which has distinct characteristics and effects compared to traditional online learning (OL). The sudden shift to online education during the pandemic presented difficulties, including inadequate preparation for learners. Though some had prior experience with online classes, the complete transition to full-time online learning was challenging for some individuals. Many students had to return to their homes, facing challenges caused by the digital divide in internet connectivity. They also experienced a sudden loss of social interaction with both peers and instructors. Furthermore, the instructors' varying levels of familiarity and training with online teaching affected the quality of learning. Finally, the pandemic placed an enormous burden on educators and students, resulting in significant disruptions to their daily lives inside and outside the university (Hodges *et al.*, 2020).

However, online education allows HEIs to reach a broader, more diverse student population, transcending geographical boundaries and time constraints (Allen and Seaman, 2013). This benefits students who may not have access to traditional on-campus programs, improving their educational opportunities and potential career prospects. Online and hybrid teaching models have provided students with greater flexibility in course delivery.

Learners can now balance their academic interests with their professional and personal responsibilities (Hodges *et al.*, 2020).

3.2 Technostress

Incorporating technology into Higher Education Institutions (HEIs) has yielded various advantages. Technology-assisted learning systems have simplified access to information, enabling students to participate in customized and self-directed learning experiences (Bates, 2019). The potential for collaborative education has grown with digital platforms and resources, encouraging student involvement in virtual team projects and global knowledge exchange (Gikas and Grant, 2013). Moreover, technology has proven advantageous to academia by aiding administrative tasks, enhancing student communication, and introducing innovative teaching techniques, including blended learning and flipped classrooms (Kaputa, Loučanová and Tejerina-Gaite, 2022). The integration of technology in higher education holds the potential to improve educational outcomes and equip students with necessary digital skills.

However, it is imperative to acknowledge the negative impact of technology overuse in higher education institutions on students and faculty. Extensive usage of digital devices and platforms leads to technostress, characterized by information overload, perpetual connectedness, and digital exhaustion (Ragu-Nathan *et al.*, 2008). Following the pandemic, introducing new educational practices (such as hybrid learning environments) proves excessively challenging (Skulmowski and Rey, 2020). Technology integration forces students to adapt to software and communication tools. As a result, individuals experience technological fatigue and stress during learning (Shen and Kuang, 2021). Such strain and fatigue caused by technology are known as "*technostress*" (Cao, Xu and Ali, 2023). Introducing new technologies in hybrid learning considerably burdens students with information, communication, and social overload (Olabode, Abayomi and Sunguh, 2019), causing a detrimental impact on their academic progress due to technostress. Higher education institutions are therefore advised to prioritize educating individuals on digital literacy and encouraging the cautious use of technology to manage technostress effectively. Efforts should be made to devise techniques that can mitigate undesirable effects, optimizing the benefits of technology in the education field while minimizing any possible disadvantages (Ribble, 2015).

3.3 Academic Performance

In the hybrid learning environment setting, students must adapt to learning technologies proactively and dynamically (Behzad *et al.,* 2022). In the pandemic scenario, education is transforming quickly, and no one expects prompt changes, which may hinder acceptance and adaptation. Adapting new norms, such as a hybrid learning environment, provides students with a platform and contemporary experience to access in-person and online modalities (Rodriguez-Paz *et al.*, 2021). The shift from in-person to online and online to in-person is also associated with academic performance (Bülow, 2022; Siron, Wibowo and Narmaditya, 2020). On the contrary, increasing technostress during the pandemic due to overload and using new applications and digital competencies becomes a challenge for students (Olabode, Abayomi and Sunguh, 2019; Olivares *et al.*, 2021). Therefore, academic performance is associated with the hybrid learning environment, and technostress mediates such a relationship.

3.4 Mediating Role of Technostress Between Hybrid Learning Environment and Academic Performance

Technostress plays a significant role in the performance evaluation of hybrid learning; that is why 'Hyflex+Tec' has been proposed. I suppose the technostress mediates in both actors, i.e., academician and student performance, because of associated parameters. For instance, overload of delivering lectures and excess of perceiving talks, negative emotions due to sitting for long hours at the screen, less social life, an adaptation of AI-based learning (Cao, Xu and Ali, 2023; Regan *et al.*, 2012; Rodríguez-Galván *et al.*, 2022) which is itself sometimes challenge for academician those are not hands-on ICT (Sharma and Gupta, 2023). In summary, it has both direct and indirect impacts.

3.5 Research Problem

H1: A perceived hybrid learning environment is associated with academic performance.

H2: A perceived hybrid learning environment is associated with technostress.

H3: Technostress is associated with academic performance.

H4: Technostress mediates the relationship between the perceived hybrid learning environment and academic performance.

3.6 Need of Study

Proposing new theories should not always be correct. Every solution has its advantages and limitations. Similarly, during the COVID-19 pandemic, fully online learning was initially preferred due to the lockdown because no other options were available. Later, the hybrid learning trend started when COVID-19 began to normalize slowly and steadily. It comes under general practice after every implementation; there must be rigorous evaluation to explore the accuracy and sensitivity of the proposed solution because, practically, the ground situation is much different due to several unseen parameters. Due to this, we have taken the survey to perform the regression analysis, and we found that technostress is a crucial factor among students. It impacts health in terms of anxiety, high blood pressure, depression, sedentary lifestyle, etc., which leads to other non-communicable diseases. Not only this but this technostress is also correlated to privacy and data breaching of sensitive information.

4. Research Design and Methods

4.1 Research Design

This empirical study highlights the perception of hybrid learning environments through the HyFlex+Tec model in Tecnologico de Monterrey. Furthermore, investigating the impact of technostress in the hybrid learning environment of the education setting of HEIs. For a better understanding of the impact of technostress in a hybrid setting, we designed and online distributed a Google Form among undergraduate students through a convenient sampling approach. Empirical findings provide in-depth insights into the mediating role of technostress within a hybrid learning environment and its effects on students' academic performance.

4.2 Participants and Procedure

The participants of this study were final year undergraduate students currently enrolled in four schools of Tecnologico de Monterrey, i.e., (1) School of Architecture, Arts and Design, (2) School of Government and Public Transformation, (3) School of Business, and (4) School of Science and Engineering. All participants do not have prior experience of e-learning or hybrid learning. During the first and second quarters of 2021, the online survey was distributed through a convenient sampling approach. In this period, students gradually moved from hybrid to in-person learning mode. So, all students have an experience of the hybrid learning environment. For data collection, we requested anonymous professors to distribute the survey link during their lecture sessions conveniently. After the cutoff date of the online survey, we received 94 complete responses out of 127.

4.3 Measurements

The online survey contains a set of questions related to (1) demographic information, (2) perceived hybrid learning environment, (3) technostress, and (4) academic performance.

1. **Demographics information:** contains questions about gender, age, specialization, and scholarship of undergraduate students.
2. **Perceived hybrid learning environment:** The first construct we adapted four times from the published work of Butz and Stupnisky (2016) contains a 5-point Likert scale with a reliability value of α=0.659.

- I can bridge the gap to connect with online – and on-campus students.
- Interaction with my online campus classmates enables me to form meaningful relationships.
- I can overcome barriers that prevent me from building friendships with online, on-campus students.
- I can develop social relationships with my online campus classmates.

3. **Technostress:** For the second construct, we adapted six items from the work of Galvin, *et al.* (2021) and measured with a 5-point Likert scale, with a reliability value of α=0.725.

- A hybrid learning environment (HyFlex +Tec) creates problems I would otherwise experience.
- I feel pressured due to the hybrid learning environment (HyFlex +Tec).
- The capabilities provided by a hybrid learning environment are reliable.
- A hybrid learning environment (HyFlex +Tec) behaves highly consistently.
- A hybrid learning environment (HyFlex +Tec) enables others to have access to me.
- A hybrid learning environment (HyFlex +Tec) enables me to be in touch with others.

4. **Academic performance:** We adapted four items from Trockel, Barnes and Egget (2000) work for the third construct. These items were measured with a 5-point Likert scale, with a reliability value of α=0.725.

- In a hybrid learning environment (HyFlex +Tec), I often (online-on-campus) meet my academic needs.
- I often manage time and meet responsibilities in a hybrid learning environment (HyFlex +Tec).
- I often feel anxious or worried in a hybrid learning environment (HyFlex +Tec).
- In a hybrid learning environment (HyFlex +Tec), I often feel overwhelmed by the time pressure.

Cronbach alpha value of all constructs was per Cronbach's (1951) and Kaiser's (1974) set criteria of data reliability, that is, $\alpha>0.6$

4.4 Statistical Analysis

After data collection, we applied the data cleaning and pre-processing steps for better regression analysis. As the data was collected, we assigned labels to all the variables and numeric codes to each response. After data curation, we analyzed the empirical data using the Jamovi software application. Firstly, we applied descriptive statistics to obtain the summary of demographic information by frequency and percentage. Secondly, we performed Pearson's correlation to test the association between variables. Thirdly, we applied factorial analysis to test the goodness fit of the model. Finally, we used a mediation test to confirm the influence of the mediator (technostress) between the independent (perceived hybrid learning environment) and dependent (academic performance) variables. The following section discusses the results of the descriptive statistics, correlation, confirmatory factor analysis, and mediation test.

5. Analyzed Results

5.1 Common Method Bias

Before formal analysis, we applied the common method bias to ensure that the data was free from discrimination. To verify data bias, we combined all 18 items of the three variables and applied principal component analysis, selecting "None" as the rotation method and setting the number of components to 1. We get a 48.6% variance, which is less than 50%, meaning that the data is not biased (Fuller *et al.*, 2016).

5.2 Demographics of the Participants

In Table 1, we present the demographics of the participants based on frequency and percentage: 48 (51.1%) out of 94 students were female, and the remaining 46 (48.9%) were male. 35 (37.2%) of the students were aged between 18 and 21, and 45 (62.8%) were 22 years and above. Most students specialized in social science and management, 34 (36.2%), and 60 (63.8%) specialized in IT and engineering. We did not receive any response from students majoring in natural sciences. 47 (50%) students held full scholarships, and the remaining 47 (50%) self-financed their studies.

Table 1: Demographics of the participants based on frequency and percentage

	Frequency	Percentage (%)
Gender		
Female	48	51.1%
Male	46	48.9%
Age		
18 and 21 years	35	37.2%
22 years and above	45	62.8%
Specialization		
IT and Engineering	34	36.2%
Social Sciences and Management	60	63.8%
Scholarship		
No	47	50%
Yes	47	50%

Source: Own calculation

5.3 Correlation Analysis

In Table 2, Pearson's correlation analysis results show the significant association between all three variables, i.e., perceived hybrid learning environment, technostress, and academic performance. The perceived hybrid learning environment has a positive significant correlation with academic performance (r=0.723, p<.001), whereas technostress is also significantly associated with academic performance (r=0.664, p<.001).

Table 2: Correlation analysis results

	PHLE	TS	AP
PHLE	–		
TS	0.815***	–	
AP	0.723***	0.664***	–

Note; PHLE=Perceived hybrid learning environment; TS=Technostress; AP=Academic performance; Level of significance ***p<0.001

Source: Own calculation

5.4 Confirmatory Factor Analysis (CFA)

The factorial analysis technique is helpful to test the proposed research model. So, for the goodness of fit test, we applied the factorial analysis technique known as confirmatory factor analysis (CFA). The CFA test aims to propose and validate a research model through exact fit and fit measures. The based value of "test for exact fit," i.e., χ^2/df=1.89, is within the acceptable range, i.e., χ^2/df<3.00. The base value of "*fit measures*" is within the set reasonable fit range, i.e., CFI=0.896, TLI=0.872, RMSEA= 0.0971, and RMSEA 90% CI (Lower=0.0720, Upper=0.122). So, the value of "*test for exact fit*" and "*fit measures*" was in accordance with Abbas, *et al.* (2021) and Xia and Yang (2019) set criteria for goodness of fit statistics for the measurement of a model.

5.5 Hypotheses Testing

In this section, we explain our analyzed regression results, which include the total, indirect, and direct effects.

In Table 3, the analyzed regression results show that a perceived hybrid learning environment is associated with academic performance. In Table 3, the results support **H1**: (β=0.644, p<.001). Similarly, in Table 4, β=0.723 (p<.001), thus supporting **H2**: Perceived hybrid learning environment is associated with technostress. Given the analyzed results in table 5, **H3** (β=0.701, p<.001) and **H4** (β=0.410, p<0.065) are also supported. Technostress is associated with academic performance and mediates the relationship between a perceived hybrid learning environment and academic performance. The value of 95% confidence interval (CI) and absence of zero between lower and upper bounds confirm that full mediation exists.

Table 3: Total effects predicting: Academic performance

				95% C.I.				
Name	Effect	Estimate	SE	Low	Upper	β	Z	p
PHLE	PHLE	0.841	0.0982	0.649	1.034	0.644	8.57	p<.001

Note. PHLE=Perceived hybrid learning environment; C.I.=Confidence Interval; β=Beta; Level of significance= *p<0.05, **p<0.01, ***p<0.001

Source: Own calculation

Table 4: Dependent variable: Technostress

				95% C.I.				
Name	Effect	Estimate	SE	Low	Upper	β	Z	p
PHLE	PHLE	0.951	0.094	0.767	1.134	0.723	10.14	p<.001

Note. PHLE=Perceived hybrid learning environment; C.I.=Confidence Interval; β=Beta; Level of significance=p

Source: Own calculation

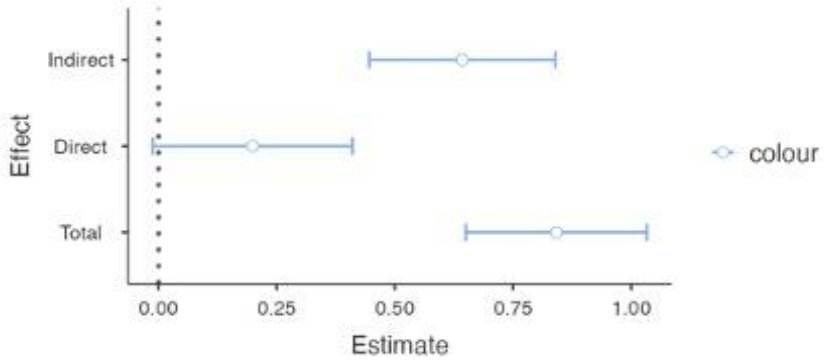
Table 5: Full model predicting: Academic performance

				95% C.I.				
Name	Effect	Estimate	SE	Low	Upper	β	Z	p
TS	TS	0.676	0.0819	0.515	0.836	0.701	8.25	<.001
PHLE	PHLE	0.199	0.1077	-0.012	0.648	0.410	1.85	0.065

Note. PHLE=Perceived hybrid learning environment; C.I.=Confidence Interval; β=Beta; Level of significance=p

Source: Own calculation

The estimation plot shows that the total effect has a higher estimate. After introducing the mediator, the indirect impact is lesser than the direct effect, which indicates complete mediation (see Figure. 1).



Source: Own compilation

Figure. 1: Estimate plot (Total, direct and indirect effect)

6. Discussion

In the discussion section, we discuss the proposed hypotheses and the analyzed findings of this empirical study. The results thoroughly explore the mediating role of technostress among perceived hybrid learning environments and students' academic performance. Furthermore, this section thoroughly discusses our empirical findings with the support of existing literature.

First, this study confirms that a perceived hybrid learning environment is associated with academic performance. Rodriguez-Paz, *et al.* (2021) argued that successfully implementing a hybrid learning environment supports students to accept new norms during the pandemic and ensures the promotion and continuation of quality education at all levels. During COVID-19, the shift in the learning mode resulted in benefits and challenges among students (Li, 2022). In the Mexican context, students at a private university have previous experience with and access to digital resources. In some cases, HEIs support their students by providing them with internet access and digital devices (Aguilera-Hermida *et al.*, 2021) for the continuation of study and improvement of performance.

Although many students had prior experience with online learning, the sudden transition from face-to-face teaching to entirely online and hybrid learning imposed new challenges on both learners and educators. Wang, Tan and Li (2020) similarly suggest that mismatches between students' characteristics, needs, abilities, and technological and educational contexts can result in technostress. This can occur when there is a mismatch between the student's characteristics and the learning environment, potentially resulting in frustration, anxiety, or decreased learning outcomes (Wang, Tan and Li, 2020). Similarly, faculty members are also affected. Multiple studies indicate that the abrupt transition to online education and the increased reliance on technology for teaching, communication, and administrative tasks due to the pandemic have led to greater levels of technostress. The proposition is that while the use of technology and blended learning was not unfamiliar to either faculty or students, the sudden and complete shift from face-to-face education to online and hybrid learning within a limited timeline proved to be a challenging experience for learners and faculty alike, particularly in instances where there was a mismatch between a person and their educational environment, with no other available learning model as an option (Wang, Tan and Li, 2020; Boyer-Davis, 2020).

The second finding confirms the associations between the perceived hybrid learning environment, technostress, and students' academic performance. According to Alexa, *et al.* (2022), COVID-19 affects the learning process, student focus, load, and communication between teachers and peers. So, the change in modality during the pandemic and the implementation of hybrid educational models in educational settings also exert emotional effects. One of the factors of such impacts is technostress. Technostress is associated with the heavy use of IT or information technologies in specific settings (Tarafdar *et al.*, 2007).

Lastly, technostress mediates the association between the perceived hybrid learning environment and students' academic performance. Technostress is a mediator. Olabode, Abayomi and Sunguh (2019) mentioned that technostress occurs due to failure to cope with emotional and psychological discomfort with the high possibility of regularly engaging with digital technologies. Handayani and Sulastri (2022) argued that technostress is associated with the inability to use new technologies, which impacts the health and performance of the users. Therefore, students primarily engage with and switch between in-person and online learning in the hybrid learning environment. This may affect motivation, technical issues, and a lack of interaction with peers and teachers. Adapting to the hybrid learning environment (Lorenzo-Lledó *et al.*, 2021) causes anxiety and stress in their daily routine and affects their academic performance. The significance of this study is not to make the teaching methods more complex so that they have an adverse impact on mental and physical growth. Christian, Purwanto and Wibowo (2020) explores the results obtained by the analysis using SPSS, which shows that online and hybrid learning increases the stress level for teachers and students by adding an extra load.

7. Conclusions

The evaluation of hybrid learning is a serious concern. This study will help educationists update or bring new reformations to the current model to excel in the current approach. Due to this, the proposed results obtained from regression analysis concluded that technostress fully mediates the relationship between the perceived hybrid learning environment and students' academic performance. Technostress mediates due to the continuous change in modalities, which burdens students as they must learn and adapt to new digital tools to participate in course-based activities. The other cause of technostress is the hybrid learning environment, where students attend classes in person and online. This shift in modalities causes technostress, affecting students' academic performance. However, it also has limitations in that the collected data is from one university campus, but this will open the gate for future researchers to extend our work and deploy an online survey to all 26 Tecnologico de Monterrey campuses or other academic institutions. This will enhance the understanding related to the acceptance of hybrid educational models and their effects on student's academic performance.

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Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

Asad Abbas: Conceptualization, literature review, research design, survey design, data collection, data curation, formal data analysis, validation, writing—final draft, revisions and editing.

Guillermina Benavides Rincón: Literature review, data collection, writing—review, revisions, and editing.

Liya Wang: Writing—review and comments.

Mohammad Khubeb Siddiqui: Literature review, writing—review, comments, revisions, and editing.

All authors read and approved the final manuscript.

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