Effects of Technological Factors and Mental Workload in Online Higher Education Students' Academic Performance

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Abstract

The pandemic caused by Covid-19 has led university students in Mexico to take their classes online, where they have to interact with furniture and computer equipment different from the one that exists in classrooms. Interaction with such furniture and equipment can be uncomfortable and have an impact on the students' Academic performance. Therefore, this article aims to determine the impact of Desk / Table design, Chair design, and Human-computer interaction (antecedent variables), as well as the Mental workload (mediating variable) on university students' Academic performance (consequent variable) during the Covid-19 pandemic. A questionnaire is developed and applied online to 167 university students, and three mediation models were built where seven hypotheses are included. These hypotheses were statistically validated by applying the ordinary least squares regression algorithm. The results indicated that the three antecedent variables have a significant direct effect as well as total effects of 0.21, 0.14, and 0.49, respectively, while total effects of 0.22, 0.17, and 0.49 on the university students' Academic

performance. The indirect effects were negligible. It is suggested that the three antecedent variables play an essential role in the sustainability of university students.

Keywords
Academic performance, Desk/table design, Chair design, Human-computer interaction, Mental workload

1. Introduction
Ergonomics is the scientific discipline that is responsible for analyzing human interaction and other elements of a system (such as environmental, technological, and psychosocial factors), and the profession that applies theory, principles, data, and design methods to optimize human well-being and overall system performance (International Ergonomics Association (IEA) 2018). Similarly, sustainability, in its socioeconomic dimension, is defined as the ability to use available resources (including human resources) efficiently and to guarantee that human well-being conditions (safety, health, education) are equally distributed among classes to ensure their profitability over time (Barile et al. 2018). That problem indicates it is necessary to provide an efficient design of the conditions in which human resources operate to improve the use of their physical and psychosocial capacities, keeping them profitable over time and allowing sustainable development.

Literature shows evidence that there is a relationship between ergonomics and sustainability. For instance, a poor design of the work area represents a risk factor for individuals due to the uncomfortable conditions they are exposed to, especially when they are forced to work for several hours a day, affecting their well-being. Poor design of the work area causes people to be forced into uncomfortable body postures, leading to musculoskeletal disorders (MSD).

The ergonomic design of workstations contributes to the sustainable human development. The ergonomic design of workstations is essential to improve the sustainability and physical suitability of a work area. In addition, an ergonomic design positively impacts sustainability, improving the useful life of workstations. Therefore, the ergonomic design allows improving the sustainability of the human resource, facilitating its efficient use.
One of the job sectors where individuals (students) can be exposed to different risks due to the lack of ergonomic design in elements they interact with, it is the education sector. Uncomfortable and unsafe conditions in the classroom may affect student's Academic performance.

In March 2020, the World Health Organization declared the novel coronavirus SARS-CoV-2 (COVID-19) outbreak to be a pandemic. This situation has caused that Mexican professors have to work from home (infobae 2020), teaching online classes (distance learning), which in turn has led students to take online classes from a different location but in classrooms at a school campus (Grupo Fórmula 2020). This has made students to adapt themselves to new conditions in their new job areas when taking online classes. On the one hand, taking classes online can increase Mental workload. This problem is due to the speed professors teach their online classes in which they need to learn to use new technological resources (such as Classroom, Google Meet, Teams, and Drive; to name a few) to fulfill their work in class.

Also, students have to interact with their new study station (computer, mouse, chair, table/desk, electrical outlet), which, if it is not designed from an ergonomic approach, can cause students to adopt forced and uncomfortable postures in each of the different body segments, which can have an impact on their Academic performance. So far, there is no research on the effects that technological factors (Desk / Table design, Chair design, interaction with electronic devices) have on higher education students' Mental workload and Academic performance in Mexico when these factors are used while taking online classes.
Based on the previous mentioned backgrounds, this research aims to determine the impact that these factors have on the level of university students' Mental workload and the Academic performance who take online classes in Mexico.

The rest of the document is structured as follows: Section 2 depicts a literature review on the effects of technological factors (table/desk design, chair design, interaction with electronic devices) on the level of mental workload and student's Academic performance. A literature review on studies that are concerned with the last two variables are also included. Section 3 presents the methodology applied to determine the impact of these variables on students' Academic performance who take online classes in Mexico. Section 4 shows the results obtained when applying the methodology. Finally, section 5 shows the conclusions and a discussion of the results obtained in this research.

2. Literature review
2.1 Effects of furniture design (desk and chair) on Academic performance
Assiri et al. (2019) mention that school furniture that does not comply with an ergonomic design may be responsible for students adopting a bad posture, influencing their learning abilities. López-Chao et al. (2019) analyzed how learning spaces can influence university students' Academic performance. Among the variables that these authors considered in their holistic approach there

were the Desk/table design and Chair design. Their analysis found that students' lack of physical comfort affects negatively their concentration and Academic performance. This discomfort occurs mainly when tables and chairs are fixed.

Based on this background, the following two hypotheses are proposed:

H_1: The Desk/Table design used in online classes during the Covid-19 pandemic has a significant impact on university students' Academic performance in Mexico.

H_2: The Chair design used in online classes during the Covid-19 pandemic has a significant impact on university students' Academic performance in Mexico.

2.2 Effects of Desk/Table and Chair design on Mental workload level

Mental workload refers to the part of a person's ability to process information as well as the resources required to meet the demands of a specific task (Eggemeier et al. 1991). Alyan et al. (2020) discovered that ergonomic workstations improve task performance and decrease students' Mental workload. Mosaly et al. (2020) showed that workspace design has no significant effect on the Mental workload level. Vink et al. (1995) found a relationship between the design of the work area or furniture and the Mental workload level. Based on this background, the following two hypotheses are proposed:

H_3: The Desk/Table design used in online classes during the Covid-19 pandemic has a significant impact on the university students' Mental workload in Mexico.

H_4: The Chair design used in online classes during the Covid-19 pandemic has a significant impact on the university students' Mental workload in Mexico.

2.3 Effects of Human-computer interaction on Academic performance

Literature mentions a relationship between Human-computer interaction and a person's performance when performing school activities. For example, the prolonged use of mobile devices to access and analyze information can cause cognitive problems, negatively affecting students' Academic performance (Jones 2009). Fischer, Xu, Rodriguez, Denaro, and Warschauer (2020) conducted a quantitative study to analyze the impact of online classes on Academic performance. Their results indicated that students who took courses online performed poorer academically than students who took classroom courses. Similarly, Xiao and Ran (2020) examined the effects that online teaching can have on undergraduate students' Academic performance during the COVID-19 pandemic. Their research revealed that the implementation of their teaching model had a positive impact on students' Academic performance. These antecedents allow to formulate hypothesis H_5:

H_5: Human-computer interaction in online classes during the Covid-19 pandemic has a significant impact on the university students' Academic performance in Mexico.

2.4 Effects of Human-computer interaction on Mental workload

Some research shows that Human-computer interaction can cause an increase in the level students' Mental workload. For example, Stuijfzand et al. (2016) showed that the time required for students to locate a relevant structure in an image was significantly related to pupil dilation, cataloged as a sign of Mental workload. In other similar research, Jost, Cobb, and Hämmerle (2019) examined the effects of reality-based interaction (RBI) and virtual reality (VR) on Mental workload measures in sixty high school students. Their results found a significant effect of RBI on Mental workload.

Jones (2009) analyzed the relationship between the use of mobile devices for learning and Mental workload. This research provides evidence that mobile learning technologies with higher levels of task load affected the level of Mental workload in students. These antecedents serve as the basis for proposing hypothesis H_6:

H_6: Human-computer interaction in online classes during the Covid-19 pandemic has a significant impact on the university students' Mental workload in Mexico.

2.5 Effects of Mental workload on Academic performance

Atalay, Can, and Erdem (2016) indicated that the Mental workload on students affects their academic motivation, which in turn affects their Academic performance. Corrales, Rojas, and Atoche (2020) mention that the excessive Mental workload negatively impacts Academic performance. Similarly, Sanders and Lushington (2002) indicate that stress affects Academic performance in dental students. These antecedents allow formulating hypothesis H_7:

H_7: Mental workload in online classes during the Covid-19 pandemic has a significant impact on university students' Academic performance in Mexico.

Figure 1 shows the hypothetical causal models of the present investigation. To illustrate, X_i represents the independent or antecedent variables, the M represents the mediating variable, and Y represents the consequent variable.

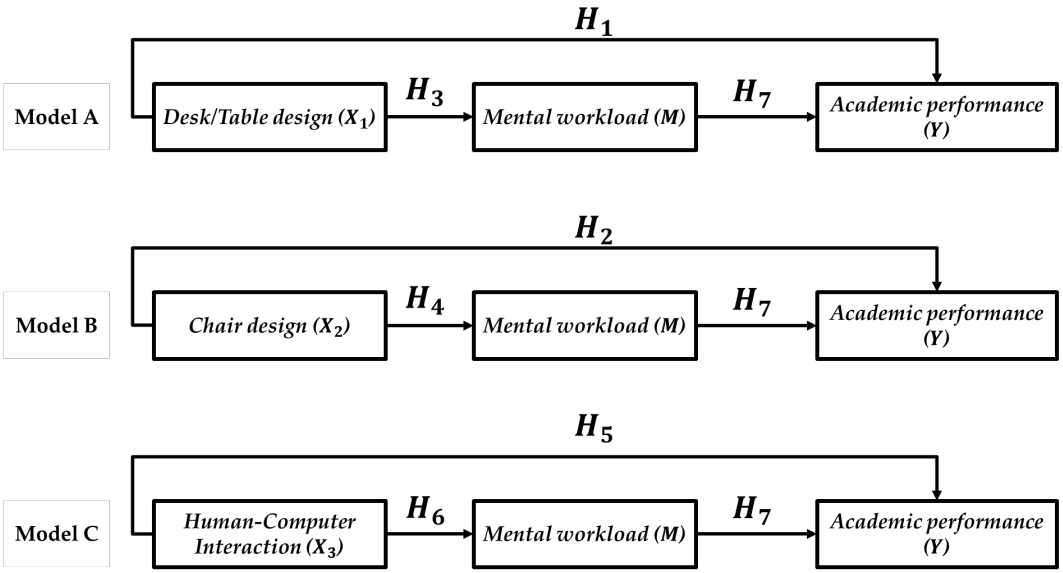

Figure 1. Hypothetical causal models

3. Methodology

The methodology implemented in this research is divided into four stages: (1) development of a questionnaire, (2) application of the questionnaire; (3) statistical analysis of the data; and (4) interpretation of the results.

The literature presents various studies that deal with the effects of technological conditions (specifically Desk / Table design, Chair design, and Human-computer interaction) and Mental workload, which may affect students' Academic performance. However, none of these studies analyzed the interaction of the five variables shown in Figure 1 in which higher education students interact when taking online classes during the Covid-19 pandemic. Based on these antecedents, the Questionnaire of Effects of Online Classes on higher education students' health and Academic performance (QEOC) is developed. The QEOC consists of 8 sections: (1) Introduction, (2) demographic data, (3) environmental factors, (4) technological factors, (5) motivation, (6) Academic performance, (7) Mental workload, and (8) effects of online classes on students' health. Given that the objective of this research is to measure the impact of technological factors as well as the level of Mental workload on the students' Academic performance, this research only covers sections (4), (6), and (7). To formulate the questions in sections (4) and (6), a literature review is developed, which includes items on the impact of Desk / Table design, Chair design, and Human-computer interaction (independent variables) on the students' Academic performance (dependent variable). This literature review is carried out in databases, such as Taylor & Francis, SAGE Journals Ebscohost, Emerald, and Sciencedirect, to mention a few. The main keywords used in the search are "Desk / Table design", "Chair design", "Human-computer interaction", "Online classes", "Academic performance", "school", "students."

Once the items are available for all the variables, they are adapted to apply them in a context of online classes, that is, where students take classes outside the educational institution facilities. Table 1 presents the items and references where they were adapted from.

After the questions are formulated, they are registered in a Google form document. The QEOC must be answered on a 5-point Likert scale, where 1 = Never, 2 = Almost never, 3 = Sometimes, 4 = Almost always, and 5 = Always. This scale is adopted, since it has been used in recent and similar studies (García-Alcaraz, Flor-Montalvo, Avelar-Sosa, Sánchez-Ramírez, & Jiménez-Macías, 2019).

Table 1. References for the items of the Questionnaire on Effects of Online Classes (QEOC) on higher education students' Academic performance

Variable	Item	Reference
Desk/Table design	The Desk/Table design always allows me to take classes online comfortably and safely (there is no pain in legs, back, neck, arms, hands, fingers, wrists) no matter how long I interact with it.	(López-Chao 2017)
Chair design	The Chair design always allows me to take classes online comfortably and safely (there is no pain in legs and backside) no matter how long I interact with it.	(López-Chao 2017)
Human-computer interaction	Online classes through a device (cellphone, computer, tablet) have improved my concentration and understanding of the class.	(Xiao and Ran 2020; Fischer et al. 2020)
Academic performance	By taking online classes, my grades have improved.	(Olmedo-Moreno et al. 2020)

The students' Mental workload level was measured by applying the NASA-TLX method, since it is the most widely used method to measure this variable (Galy, Paxion, & Berthelon, 2018). The NASA-TLX method is divided into two parts. The first part evaluates each dimension (mental demand, physical demand, time demand, performance, effort, and frustration) separately. To do this, students must select a value between 1 = Low, and 20 = High (only for the performance dimension, 1 = Good, and 20 = Poor). The second part of the NASA-TLX method comprises the paired comparison of the six dimensions. In this section, students must decide in each paired comparison which of the dimensions contributes the most to increase their Mental workload level during online classes. Once the students finish answering the items of the NASA-TLX method, the Mental workload level of each student is calculated by applying the equation (1).

$$\mathrm{NASA-TLX} = \frac{1}{15}\sum_{1}^{6} d_i w_i \tag{1}$$

The final Mental workload score is estimated as a weighted average, considering each dimension's contribution as well as its corresponding weight for each of the six dimensions. The weights represent the number of preferences (the number of times the student chose each dimension) in the 15 paired comparisons, in a range from 0 (not significant) to 5 (more significant than any other attribute). Subsequently, the Mental workload levels are converted to an ordinal scale according to Table 2.

Table 2. Ordinal scale for Mental workload levels

	Ordinal scale				
	Very Low (1)	Low (2)	Medium (3)	High (4)	Very high (5)
Mental workload level	1-20	21-40	41-60	61-80	81-100

As in the case of the other variables, the items corresponding to the Mental workload variable are also registered in the same Google form document.

4. Data collection

4.1 Application of the QEOC

The QEOC is applied to students who have taken online classes during the Covid-19 pandemic in 12 different universities in Mexico, regardless of whether they are undergraduate or graduate students, as well as regardless of whether the universities are public or private. The QEOC application is created online, where the two steps were followed:

(1) Searching for professors from universities in Mexico: To contact professors, first of all, we proceed to look for publications in congresses, magazines, book chapters, among others, where at least one of the authors was affiliated with a university in Mexico in which their name and email were shown.

(2) Contacting professors and students: After we had a list of teachers with their institutional emails, an email was sent to them, explaining the project and its objective. The QEOC link was shared with them, and they were asked to distribute it among all

students and professors at their university, and even with professors from other universities in the country. Other students were contacted by digital platforms, such as Classroom or Facebook.

The online survey was opened in July and August 2020. The participation of all students was voluntary.

4.2 Statistical Analysis of the Data

The statistical analysis of the data includes the statistical validation of the QEOC as well as the relationships among the variables. The analysis is carried out to test the hypotheses proposed in section 2.

4.2.1 QEOC Statistical Validation

The data collected using the questionnaire is registered in a database created in the SPSS® software (Coakes and Steed 2009). Then, since the data is gathered in an ordinal scale (Likert scale), a data screening is performed by substituting outliers and missing values by the median (García-Alcaraz, Maldonado-Macías, Alvarado, & Rivera, 2014). A 95% reliability level is used to analyze all estimations.

Next, the statistical validation of the QEOC is performed for each variable, accepting a minimum value of 0.7 for the Cronbach's alpha coefficient (García-Alcaraz et al., 2014). In this case, all observed variables with a corrected total-item correlation under 0.3 are removed from the QEOC. Only they will remain in the QEOC if the Cronbach's alpha coefficient is over 0.7.

4.2.2 Analysis of statistical diagram

To test the relationships among the observed variables in Figure 1, a mediation analysis is used, since the observed variables can play a role as antecedent and consequent variables simultaneously (Hayes 2018). The mediation analysis is performed by using the PROCESS® macro (model 4) in the SPSS® software, since it analyzes the data of observed variables with sophisticated algorithms that are based on the ordinary least squares (OLS) regression algorithm (Hayes 2012, 2018). Then, the PROCESS® macro allows the use of nonlinear models (Hayes 2018). This software is widely recommended for assessments in an ordinal scale, small-sized samples, and non-normal distribution (Lee et al., 2019). The validity of statistical inferences in a regression analysis is substantially affected only when the sample size is relatively small or when most severe violations of normality occur (Hayes 2018).

In the analysis, the R^2 and the F ratio model fit indexes are estimated before their interpretation (Hayes 2018). R^2 is a scale-free metric interpreted as the proportion of the variance in a consequent variable Y explained by the model (Hayes 2018). To be accepted, the values of R^2 must be over 0.02 (Kock 2020). The second model fit index, which is the F ratio, helps determine if there is a significant difference between the variance explained by the model and the variance that is not explained by the model. A model must be statistically significant to be considered appropriate, or the variance ratio must differ significantly from zero (Ato-García and Vallejo-Seco 2016).

The effects are measured in the serial multiple mediation model. The direct effects are considered to validate the hypotheses depicted in Figure 1. A direct effect can be interpreted as follows: when two cases that differ by one unit on an antecedent variable X are equal on a mediator M, which is estimated to differ by c' (the value of the direct effect) units on a consequent unit or consequent variable Y (Hayes 2018). Direct effects indicate direct relationships between two observed variables (García-Alcaraz et al. 2014), where a standardized β value is obtained and statistically tested as a dependence measure. The null hypothesis is that $H_0: \beta_1 = 0$, whereas the alternative hypothesis is $H_1: \beta_1 \neq 0$. When β values are different from zero, there is statistical evidence to state a relationship among those observed variables. Indirect effects occur only when one or more mediator variables are between the antecedent and consequent variable. Indirect effects can be a result of two or more segments (García-Alcaraz et al. 2014), and they are interpreted as the amount that a consequent variable Y is expected to change as an antecedent variable X changes by one unit as a result of the X's effect on a mediator variable M, which in turn affects Y (Hayes and Preacher 2010). Finally, the total effect is the sum of the direct effects and indirect effects. The bootstrap method is used to test each effect (Lee et al. 2020). According to several authors, the most accurate results from the significance verification of an indirect effect are obtained when decisions are made by a reliable interval estimated through the bootstrap method yield (Lee et al. 2020). Finally, to create 95% bias-corrected, ten thousand bootstrap samples are used, whereas accelerated confidence intervals are applied to test the significance of the direct, indirect, and total effects. All these effects are significant when $p < 0.05$, and the 95% confidence interval does not include zero (Lee et al. 2020).

As PROCESS® allows only one antecedent variable X and only one consequent variable Y in a model, the A, B, and C models are shown in Figure 1, where they are analyzed separately.

5. Results and Discussion

5.1 Sample results

One hundred sixty-seven valid surveys were collected for data analysis. From the total number of students, 91 (54.5%) were men, while 76 (45.5%) were women.

5.2 Descriptive Analysis of the Data

Table 3 shows the descriptive analysis of the data obtained for the variables and their corresponding items. In this descriptive analysis, the average, and the interquartile range (IQR) are presented. The effort required is the event that occurred the most regarding the Mental workload variable, and in general, with an average of 14.94.

Table 3. Descriptive analysis

Variable	Item	Average	IQR
Desk/Table design	The Desk/Table design always allows me to take classes online comfortably and safely (there is no pain in legs, back, neck, arms, hands, fingers, wrists) no matter how long I interact with it.	3.21	2
Chair design	The Chair design always allows me to take classes online comfortably and safely (there is no pain in legs, back, buttocks) no matter how long I interact with it.	2.92	2
Human-computer interaction	Online classes through a device (cellphone, computer, tablet) have improved my concentration and understanding of the class.	2.80	2
Mental workload	How much mental and perceptual activity is required to perform the task (for instance, thinking, deciding, calculating, remembering, searching, etc.)?	14.34	8
	How much physical activity is required, for instance, pushing, pulling, controlling, activating, turning, etc., to perform a task?	5.13	7
	How much time pressure do you feel due to the speed or rate that tasks or elements of tasks occur?	13.92	8
	How hard do you have to work (mentally and physically) to achieve good performance?	14.93	9
	How satisfied are you with your performance based on the achievement of your objectives?	10.89	11
	How insecure, discouraged, irritated, stressed, and upset do you feel during the performance of your tasks?	13.15	8
Academic performance	By taking online classes, my grades have improved.	3.37	1

5.3 QEOC validation

The Cronbach's alpha value from the QEOC was 0.706. If any of the variables were removed from the QEOC, the Cronbach's alpha value decreased. Based on these results, the QEOC can be considered as reliable.

5.3.1 Analysis of the hypothetical causal model: direct, indirect, and total effects among variables

Figure 2 shows the direct effects values of β from an antecedent variable on a consequent variable. Moreover, the significance of the effects is represented by the p-values used for the hypothesis test. Note that only the p-value for the effect of Mental workload on Academic performance was over 0.05 (red arrows) in the three models. Then, the relationship between Mental workload and Academic performance is insignificant and can be rejected. All the other three relationships (black arrows) are significant, since the p-value is under 0.05. Note that all antecedent variables, Desk/Table design, Chair design, and Human-computer interaction had a significant negative effect on Mental workload, but a significant positive effect on Academic performance. This means that when the ergonomic design of antecedent variables increases the Mental workload decreases, while Academic performance increases.

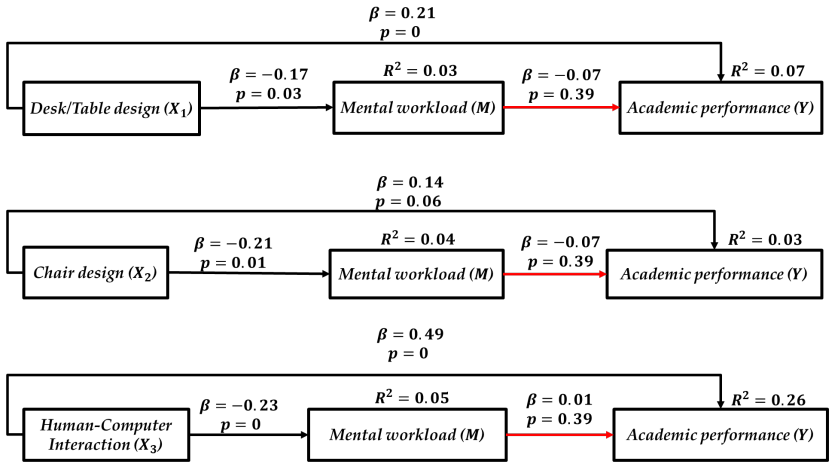

Figure 2. Direct effects among variables

The values of R^2 indicate how the antecedent variables explain variance for consequent variables (Hayes 2018). On the other hand, the β values are interpreted as dependency measures. For instance, according to the β values that are shown in Figure 2, when the Chair design increases its standard deviation by one unit, the consequent variable of Academic performance increases its standard deviation by 0.49 units, since the β value among these variables is 0.49. Table 4 shows the regression coefficients (Coeff.), standard errors (SE), constants, and model summary information for the three mediator models depicted in Figure 2.

Table 4. Regression coefficients, standard errors, constants, and summary information for the three mediation models

	Consequent					
	Mental workload			Academic performance		
Antecedent	Coeff.	SE	p	Coeff.	SE	p
Desk/Table design	-0.17	20.22	0.03	0.24	0.07	0
Chair design	-0.21	20.86	0.01	0.15	0.07	0.06
Human-computer interaction	-0.23	21.91	0	0.51	0.07	0
Mental workload				-0.07	0	0.39
Constant (Model A)	1471.75	69.69	0	2.98	0.44	0
Constant (Model B)	1495.97	65.95	0	3.30	0.45	0
Constant (Model C)	1514.10	66.20	0	1.96	0.40	0
Summary of Models						
Model	R^2	F (1,165)	p	R^2	F (2,164)	p
A	0.03	4.89	0.03	0.07	5.95	0
B	0.04	7.57	0.01	0.03	2.78	0.03
C	0.05	9.20	0	0.26	28.08	0

As shown in Table 4, all R^2 values are over 0.02, and all p-values for the F ratios are under 0.05. Therefore, the models can be considered appropriate. According to the β values shown in 2 and the constant values shown in Table 4, dependent relationships for Desk/Table design, Chair design, Human-computer interaction, Mental workload, and Academic performance can be expressed by equations (2-7) (Hayes 2018):

For model A

$$\text{Mental workload} = 1471.75 - 0.17 \times \text{Desk/Table design} \quad (2)$$

$$\text{Academic performance} = 2.98 + 0.21 \times \text{Desk/Table design} \quad (3)$$

For the model B

$$\text{Mental workload} = 1495.97 - 0.21 \times \text{Chair design} \quad (4)$$

$$\text{Academic performance} = 3.30 + 0.14 \times \text{Chair design} \quad (5)$$

For the model C

$$\text{Mental workload} = 1514.10 - 0.23 \times \text{Human} - \text{Computer interaction} \quad (6)$$

$$\text{Academic performance} = 1.96 + 0.49 \times \text{Human} - \text{Computer interaction} \quad (7)$$

5.3.2 Indirect Effects

For each model, there was an indirect effect from the antecedent variable (i.e., Desk/Table design, Chair design, or Human-computer interaction) to the consequent variable (i.e., Academic performance). In each of the three models, the indirect effect was through the Mental workload, which acted as a mediator variable. The highest indirect effect was from Chair design on Academic performance, with a value of 0.02. There was no indirect effect from Human-computer interaction on Academic performance. Moreover, note that all indirect effects were insignificant, since zero is in the confidence interval [Lower Limit of Confidence Interval (CI), Upper Limit of Confidence Interval (ULCI)] (Hayes 2018). Table 5 shows the values of indirect effects and their confidence intervals for each antecedent variable.

Table 5. Indirect effects

	Antecedent		
	Desk/Table design	Chair design	Human-Computer interaction
Indirect effect value	0.01	0.02	0
LLCI	-0.02	-0.02	-0.03
ULCI	0.05	0.07	0.04

5.3.3 Total Effects

The sum of direct and total indirect effects results in the total effect (Hayes 2018). All antecedent variables had significant total effects on Academic performance since the corresponding p-values were under 0.05. The higher total effect was from Human-computer interaction, with a value of 0.49. This total effect indicates that when Human-computer interaction increases its standard deviation by one-unit, Academic performance increases its standard deviation by 0.49 units. Table 6 presents the total effects for each antecedent variable on Academic performance.

Table 6. Total effects

	Antecedent		
	Desk/Table design	Chair design	Human-computer interaction
Total effect value	0.22	0.17	0.49
LLCI	0.09	0.01	0.36
ULCI	0.35	0.29	0.61
p-value	0	0.03	0

6. Conclusions

Seven hypotheses were statistically tested to determine if there is any direct relationship among the three antecedent variables: Desk/Table design, Chair design, and Human-computer interaction, as well as an indirect relationship, mediated by the Mental workload of these three variables, along with the Academic performance obtained during the Covid-19 pandemic from Mexican higher education students who take online classes. Based on the statistical analysis performed and the results obtained, it is possible to conclude that the ergonomic design of Desk/Table, chair, and computer in which university students interact with, play a critical role in their Academic performance during distant learning. This implies that, in the case of not having furniture and computer equipment with an ergonomic design, students can be affected by their concentration, comfort, and health by suffering from back pain. This, in turn, can impact their Academic performance. Consequently, it is necessary that the Desk/Table, chair, and computer equipment where the students interact on, have an ergonomic design to improve their Academic performance. Not having ergonomically designed furniture and computer equipment can affect university students, not only in their grades, but also in acquiring knowledge and their motivation to continue with their learning process. Based on the definition of sustainability, in its socioeconomic dimension, it can be concluded that the ergonomic design of furniture and

computer equipment is essential to improve and maintain the ability to use human resources, in this case, university students, efficiently. Also, in turn, it impacts their profitability over time, and therefore their sustainability.

Moreover, this research allows us to conclude that online classes do not generate an excess Mental workload in university students since the maximum Mental workload value obtained was 60, on a scale of 1 to 100 with the NASA-TLX method. Likewise, the research also allows discovering that the mediating variable Mental workload does not impact on university students' Academic performance. Based on the above, higher education institutions must have the culture of offering classes with ergonomic design of furniture and computer equipment for students to interact with, since this allows improving the sustainability of human resources, that is, of the students, in the first instance, and the institution in the second instance.

6.1 Theoretical and Managerial Implications

Based on the results obtained from the direct and total effects of the three antecedent variables on Academic performance, the following theoretical and administrative implications were obtained:

- Academic performance depends not only on the time students spend studying or their ability to memorize information, but also on other variables.

- The ergonomic design of furniture and computer equipment is essential to improve university students' Academic performance who take online classes. This can help improve students' sustainability in the first instance and of higher education institutions in the second instance.

- Sustainability first impacts human resources (such as university students), and later companies, such as educational institutions or those belonging to the manufacturing or construction industry.

7. Further Research

As detected in this research, the university students' Academic performance who take online classes has been affected by the pandemic caused by Covid-19, specifically due to the Desk/Table design, the Chair design, and Human-computer interaction. However, other variables can have an impact on the university students' Academic performance who are taking online classes. Such variables can include the lighting, noise, and temperature of the place where the student is taking a class, online interaction with the teacher and classmates, social support, to name a few.

Therefore, as future research, different analyzes of the relationships among the variables mentioned above can be performed, for both students and university teachers. This is because not only were university students affected by the Covid-19 pandemic, but the teaching staff of higher education institutions as well, which can impact their job performance and, consequently, their sustainability.

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