Artículos científicos

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Advantages of information technology use on digital distance education during COVID-19

Vantagens do uso de tecnologias de informação na educação digital a distância em tempos de COVID-19

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Resumen

Debido a la pandemia provocada por el COVID-19, los gobiernos de casi 200 países decretaron el cierre total o parcial de instalaciones educativas presenciales con el fin de frenar la dispersión del virus. Específicamente en México, a mediados de marzo del 2020, se estableció el aislamiento social que obligó la suspensión de actividades educativas presenciales, lo que provocó la implementación de educación en modalidad *online*, por lo que las tecnologías de la información adquirieron un papel sobresaliente en el sector educativo. El objetivo del estudio, por tanto, es analizar la percepción de los universitarios en modalidad virtual sobre las ventajas de los cursos en línea, en especial en cuanto a herramientas virtuales, interacciones con profesores, interacción con materiales de aprendizaje e interacción dialógica con compañeros, controlando por género.

Para eso, se empleó un muestreo no probabilístico con 205 sujetos. La investigación buscó determinar, a través de un diseño cuantitativo y un análisis de ecuaciones estructurales, los puntos que se deben fortalecer para posibilitar el alcance, calidad e igualdad de la oferta educativa en línea. Los hallazgos indicaron que la percepción de herramientas pedagógicas y la interacción dialógica con compañeros afectan positiva y significativamente la apreciación de las ventajas de las clases virtuales. Este artículo, en definitiva, permite conocer la percepción de los estudiantes en relación con las herramientas pedagógicas y si su disposición varía según si es nativo o inmigrante digital. Por último, se considera necesario optimizar los materiales didácticos virtuales, pues se documentó que en la mayoría de los alumnos predomina un estilo de aprendizaje visual.

Palabras clave: influencia de compañeros, tecnologías de la información, cualidades de los profesores, clases en línea.

Abstract

In response to the pandemic caused by the COVID-19 the governments of almost 200 countries ordered the total or partial closure of education facilities, known as "lockdown", in order to minimize high rates of transmission of the virus (IESALC-UNESCO, 2020). In Mexico, from mid-March 2020 social isolation was implemented and all face-to-face classes suspended. This triggered widespread use of information technology and quickly became an essential resource to the educational sector in response to lockdown.The study aims to analyze the perception of undergraduate students enrolled in distance education courses, about the advantages of online classes. A non-probabilistic sampling method was used resulting in a sample size of 205 persons. The sample was quantitively assessed using structural equation models, controlled by gender and considers as predictor variables the benefits of virtual tools and ease of interaction with; professors, learning materials and dialogue with classmates. This study intends to contribute to the development of requirements for online education to promote equity and augment quality. The analysis found that perception of pedagogical online tools and dialogue with classmates has a positive perception and significantly enhances their view about the advantages of online courses. The research infers that the students' perception about pedagogical tools is a key variable, with their disposition towards technology use fluctuating depending on their digital proficiency. The professor's feedback through forums does not represent an advantage in distance

learning. The study highlights the need to improve virtual teaching resources around the visual learning style.

Key words: peer influence, information technology, teacher qualifications, online classes.

Resumo

Devido à pandemia causada pela Covid-19, os governos de quase 200 países decretaram o encerramento total ou parcial das instalações educativas presenciais, a fim de travar a propagação do vírus. Especificamente no México, em meados de março de 2020, foi estabelecido um isolamento social que obrigou à suspensão das atividades educativas presenciais, o que provocou a implementação da educação na modalidade online, pelo que as tecnologias de informação adquiriram um papel de destaque no setor educativo. O objetivo do estudo, portanto, é analisar a percepção dos estudantes universitários na modalidade virtual sobre as vantagens dos cursos on-line, especialmente em termos de ferramentas virtuais, interações com professores, interação com materiais didáticos e interação dialógica com colegas.

Para isso, foi utilizada amostragem não probabilística com 205 sujeitos. A pesquisa buscou determinar, por meio de um desenho quantitativo e de uma análise de equações estruturais, os pontos que devem ser fortalecidos para viabilizar a abrangência, a qualidade e a equidade da oferta educacional online. Os achados indicaram que a percepção das ferramentas pedagógicas e a interação dialógica com os colegas afetam positiva e significativamente a valorização das vantagens das aulas virtuais. Este artigo, em suma, permite-nos conhecer a percepção dos alunos em relação às ferramentas pedagógicas e se a sua disposição varia consoante sejam nativos digitais ou imigrantes. Por fim, considera-se necessário otimizar os materiais didáticos virtuais, uma vez que foi documentado que um estilo de aprendizagem visual predomina na maioria dos alunos.

Palavras-chave: influência dos pares, tecnologias de informação, qualidades docentes, aulas online.

Introduction

Due to the pandemic caused by COVID-19, the governments of almost 200 countries decreed the total or partial closure of face-to-face educational facilities in order to stop the spread of the virus (UNESCO International Institute for Higher Education in Latin America and the Caribbean [IESALC-UNESCO], 2020). This caused at least 1.6 billion school-age children and youth around the world to be affected by the event. Specifically in Mexico, in mid-March 2020, social isolation was established that forced the suspension of in-person educational activities, which led to the implementation of education in the online mode, which is why the use of digital tools to teach was encouraged classes.

Online education is an educational procedure of autonomous training, not in person and supported by various techniques (Juca, 2016). However, the use of information technologies (ICT) in the educational sector has generated challenges, as well as discernment of the veracity of the information available on the Internet, in addition to the digital gaps marked by the social and economic inequalities that exist in Mexico.

Regarding the university sector, in various countries the request to continue with the educational development of students and with the dissemination and production of knowledge caused the change of focus towards the virtual modality. In the first months of 2020, researchers in the area of education showed the ways in which the COVID-19 pandemic affected the educational guild that participated in online classes (Cáceres-Muñoz et al., 2020; Cao *et al.,* 2020; De la Riva and Álvarez, 2020; Kamarianos *et al.* 2020).

However, given the abundance of information about the progress of the pandemic, the lack of data on the effects it is having on students at higher education institutions stands out. Therefore, this research seeks to explore the perception of university students in virtual mode, specifically what is related to technological, pedagogical, didactic and educational environment challenges, essential aspects for professional training. The general objective is to document the real situation, advantages and disadvantages, as well as the challenges that university students face with online education, which will be beneficial for decision-making in the short, long and medium term .

In this sense, the research question was the following: what is the perception of online undergraduate students in relation to virtual tools, tutor-student interaction to support

learning, interaction with learning materials in the virtual context and dialogic interaction with classmates as predictor variables?

Goals

The study was carried out with undergraduate students from the Department of Social, Economic and Administrative Sciences of a private university in the state of Jalisco, Mexico, between June and September 2021. Three particular objectives were raised in the research: 1) analyze the convergent and divergent validity of each latent variable of the questionnaire, 2) understand the students' perception regarding the advantages of online classes and the possible factors that influence said criterion, represented by the five predictor constructs of the model, through of a structural equation model, and 3) point out the needs that must be strengthened and reaffirmed in online educational opportunities to enable the scope, quality and equality of said educational offer.

Conceptual model of research

In this research, the relationships between the constructs linked to the advantages of virtual classes are analyzed (figure 1).

Figure 1. Proposed conceptual model
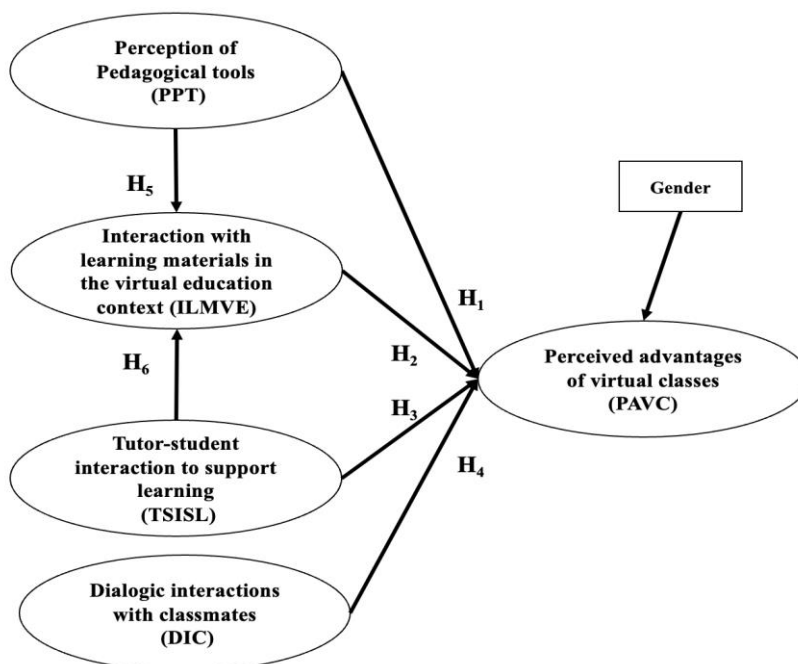
Source: own elaboration

The perception of pedagogical tools (PPT) and its relationship with the Perceived advantages of virtual classes (PAVC)

Information and communication technologies have caused important transformations in societies, as they have provided multiple opportunities to access information through various networks (Bernal-Jiménez and Rodríguez-Ibarra, 2019). This has impacted the educational area in a certain way due to the positioning of technology, since remote conversations can now be established between groups or people, as well as facilitate academic evaluations, create virtual spaces and transmit information as a learning mechanism.

In the literature, Almahasees *et al* . (2000) conducted a study focused on the usefulness of environments to specify the degree of user satisfaction with technological tools. The findings indicated that students find online education less efficient compared to face-to-face learning and teaching.

Therefore, some of the challenges that virtual education must face are related to the lack of interaction and motivation, technical and internet problems, data privacy and security. However, benefits such as self-learning, lower costs, convenience and flexibility are reported. Additionally, Varguillas and Bravo (2020) state that the advantages mentioned by students regarding ICT were the following: 1) carry out consultations and activities at any time and in any place, which simplifies and favors the administration of the course in relation to with time and space, 2) not affect the delivery of tasks and class teaching on non-working days, 3) allow the consultation of material on the platform at any time, 4) support the material for future use and 5) benefit to students who work or who do not reside at the university location. Based on the above, the following hypothesis is decreed:

H_1: Students' perception of pedagogical tools (PPT) positively influences the perceived advantages (PAVC) of virtual classes.

Tutor-student interaction to support learning (TSISL) and their relationship with the Perceived advantages of virtual classes (PAVC)

In order for teaching processes to be effective and efficient, it is necessary to promote interaction in distance educational environments (Mota *et al*., 2020; Quintero-León *et al*., 2020). Barberá-Gregori and Suárez-Guerrero (2021) define virtual interaction as a set of interconnected responses between the participants of an educational context, such that human

cognitive action is performed according to the elements that define the essence of that pedagogical content. In turn, Sánchez and García (2019) affirm that in these virtual learning environments, communication stimulates the progress of interpersonal relationships, which enhances learning and group harmony through the incorporation of collective objectives and networks of practice and teaching.

The term *interactivity*, in addition to referring to the organized action of doing and saying regarding content and tasks between teachers and students, also refers to the way in which ICT moderates and simplifies the exchange process between teachers and students (Berridi *et al*.,2015). Interactivity is analyzed according to two components: the technological and the pedagogical or instructional. Berridi *et al*. (2015) explain that the first refers to the particularities of technological tools in the environment, in the types of organization of the activity between teachers and students, and in the processes and instruments of educational impact through the use of interactivity that the teacher exercises to direct the development of knowledge in the students. The second is related to the instructional design to guide the training and study process, and its influence mechanisms through interactivity.

In distance education, it is necessary to consider that the teacher is not only a transmitter of information and that the student is not only a receiver of data (Barberá-Gregori and Suárez-Guerrero, 2021). This means that the responsibility of the student is required to build their knowledge in an interactive environment. In this new reality, the teacher must direct learning by encouraging the exchange of knowledge, which requires a more complex didactic process (Berridi *et al*., 2015; Copari, 2013). Based on this, the second hypothesis of this work arises:

H_2: Interaction with the teacher to contribute to learning (TSISL) positively influences the perceived advantages of virtual classes (PAVC).

The Interaction with learning materials in the virtual education context (ILMVE) and their relationship with the Perceived advantages of virtual classes (PAVC)

Online education modifies conservative structures in the teaching-learning process, both for students and teachers. This applies distinctive characteristics regarding the intermediation, time and channel to be used. In fact, due to innovative telecommunications

systems, people have faster and more reliable connections, which has led to a considerable increase in the exchange of information. On the other hand, globalization, computing, telecommunications and audiovisual media have generated a great impact on distance education. The results of Juca's (2016) research demonstrate that teacher preparation with the use of ICT and pedagogical quality strengthen the instruction and learning procedure, and promote innovative educational programs. Likewise, Alcivar *et al*. (2022) state that in the virtual environment, images and videos largely replace face-to-face and physical interaction, as well as oral communication. Based on these ideas, the following hypothesis is stated:

H3: The Interaction with learning materials in the virtual education context (ILMVE) positively influence the Perceived advantages of virtual classes (PAVC)

Dialogical interaction with classmates (DIC) and its relationship with the Perceived advantages of virtual classes (PAVC)

Miller and Olthouse (2013) propose two dimensions of teaching and learning in virtual environments related to interaction: internal negotiation and social negotiation. The first concept refers to the cognitive interactions that originate between the student and the topic or materials. The second concept has to do with the social interactions that arise between the student himself, his teacher and other classmates. Sánchez and García (2019) state that, in a virtual environment, communication and interaction are essential processes, since affective connections are built from these that stimulate the joint development of knowledge and learning.

Furthermore, three types of interaction must be established to favor the development of cognitive processes of virtual teaching and learning (Berridi *et al*., 2015): 1) interactions that benefit appropriate affective conditions and the existence of a favorable climate in communicative exchange; 2) interactions linked to the administration and planning of the virtual activity to clarify the objectives that must be achieved in each task or work, the evaluation criteria and characteristics, and 3) interactions that encourage the elaboration of shared knowledge through media electronic devices to build knowledge by interrelating and making use of written materials together with the educator and students. After the above, the following hypothesis is established:

H4: Dialogical interaction with colleagues (DIC) positively influences the perceived advantages (PAVC) of virtual courses.

The Interaction with learning materials in the virtual education context (ILMVE) and their relationship with the perception of pedagogical tools (PPT)

Technologies are of vital importance for learning and communication (Trejo-González, 2018). The efforts and resources allocated to the design of educational environments encourage new ways of learning; thus, instruction through ICT requires the structure of content, organization of educational activities, materials presented in different forms, various ways of communication and interaction other than traditional ones, in addition to stimulating collaborative work, reflection and negotiation (Torres and García, 2019).

In the study by Varguillas and Bravo (2020), students perceived the integration of virtuality to the face-to-face modality favorably, since they consider virtuality as a tool that allows interaction between teachers and students, since it is dynamic, modern didactics, participatory and innovative. This benefits participatory work between students, group communication and motivation to overcome limitations. Additionally, it encourages the active participation of students, who must comment, ask and respond to the topic presented. In this way, the teacher is responsible for answering the participants' questions in a timely and clear manner.

However, there are disadvantages to the virtual modality, such as personal and technological limitations. These include the lack of internet service at the workplace or home and the lack of mastery of computer tools. An example is the work of Sapién *et al*. (2020), where students point out various problems such as the absence of knowledge and skill in manipulating digital tools. That is, they know and are familiar with the use of the Internet, but very few have managed electronic databases for their research work and only a few have had access to platforms such as Zoom, Meet, Moodle, and others. Based on the aforementioned, the following hypothesis is formulated:

H_5: A positive perception of the pedagogical tools (PPT) positively influences the Interaction with learning materials in the virtual education context (ILMVE)

The Interaction with learning materials in the virtual education context (ILMVE) and their relationship with the Tutor-student interaction to support learning (TSISL)

Moreira (2019) defines interactivity in ICT-mediated instruction and training environments and conditions from a constructivist theoretical panorama. That is, interactivity refers not only to the organized processes in which teachers and students do and say to each other in relation to content and tasks, but also to the way in which ICT transforms and optimizes said activity. The latest methodological trends have been oriented towards content analysis and category recognition (Mota *et al*., 2020). However, in the literature review only Berridi *et al*. (2015) have carried out studies regarding the analysis and evaluation of the participants' opinions regarding their way of communicating or interacting in distance learning environments.

On the other hand, the role of the tutor is of utmost importance for the success of training in virtual learning environments, since he can serve as a facilitator, tutor and guide for students in the generation of knowledge through individual and group work, as well as as the interaction with the proposed materials. However, it is still necessary to obtain more valid information about what students report about their way of interacting with teachers and their perception of virtual materials. In this way, and based on the literature review obtained for the association of these two variables, the following hypothesis is identified:

H_6: A positive perception of tutor-student interaction to support learning (TSISL) positively influences the Interaction with learning materials in the virtual education context (ILMVE).

Materials and method

Study population

For data collection, non-probabilistic convenience sampling was used with a total of 205 persons. The questionnaire was administered to students from courses belonging to Bachelor's degrees in the Department of Social, Economic and Administrative Sciences, as well as to two courses in Engineering, all of them a private university in the city of Zapopan, in the state of Jalisco, who participated voluntarily. Given the missing values in some of the questionnaire items, 9 records were eliminated, resulting in a total of 196 persons in the final database. The information for the research was collected in the first quarter of 2022 through an online survey with Qualtrics, which was disseminated by the faculty's professors.

Selection of participants

Measuring instrument for online classes

Tables 1 and 2 show the study variables in order to measure the advantages of courses taught online, as well as the four dimensions of the proposed model through 62 items (annex I): 28 for PPT obtained from Sapién *et al*. (2020), 10 for ILMVE proposed by Berridi *et al*., (2015) , 10 for TSISL developed by Berridi *et al*. (2015), 9 for DIC stated by Berridi *et al*. (2015) and 5 regarding PAVC stated by Bazán-Ramírez *et al*. (2020). For this, a five-point Likert-type scale was used for each item.

Table 1. Study variables

Variables	Statements
x1	Do I use the computer and/or other information technologies when making presentations in class?
	I use the following device to connect to virtual classes:
x2	Desktop computer (PC)
x3	Laptop or notebook
x4	Tablet
x5	Cell phone (Android, Apple, BlackBerry)
x6	Due to the contingency due to covid-19, I use as a social network in my classes:
x7	Facebook
x8	WhatsApp
x9	Instagram
x10	Youtube
x11	Twitter
	Given the contingency due to covid-19, I have used the platforms in classes:
x12	Moodle
x13	Canvas

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Investigación y el Desarrollo Educativo
ISSN 2007 - 7467

x14	Teams
x15	Zoom
x16	WhatsApp
x17	Facebook
x18	Computing cloud (Google Drive, Box, One Drive, Dropbox)
	Information and communications technologies (ICT) present in my virtual classes in the face of the covid-19 health contingency:
x19	Connection failures
x20	Less teacher-student communication
x21	Access to many distractors
x22	Less learning
x23	Lack of interaction with colleagues
x24	Difficulty in handling them

Source: own elaboration

Table 2. Study variables

Variables	Statements
	What level of satisfaction do you have about the use of virtual platforms used at the university?
	The information and communications technologies used in their virtual classes are:
x25	Dynamics
x26	Accessible
x27	Simple
x28	Flexible
x29	Complicated
x30	I have been able to resolve doubts about the study topics thanks to the feedback from my advisor.
x31	The advisor is a companion in my training process.

x32	I receive support from my advisor when I have difficulties completing an assignment.
x33	The advisor motivates my participation.
x34	My advisor's comments on my work make me reflect on what I have learned.
x35	The interventions are clear from the advisor in the discussion forums.
x36	I receive feedback from my advisor when he delivers evaluations.
x37	The advisor constantly intervenes to support the forum discussion.
x38	I receive support from the advisor when I have technical difficulties.
x39	When assignments are difficult to solve, the advisor provides help.
x40	The content of the materials makes it easier for me to study the subjects.
x41	The course materials are easy to understand.
x42	Contents in different formats (textual, visual, multimedia) support learning about the topic.
x43	The diversity of the materials is adequate for understanding the topics.
x44	The learning activities are appropriate for the course contents.
x45	I find information in the materials to do my work.
x46	I find information in the materials to resolve doubts.
x47	The information in the study materials is sufficient to take the exams.
x48	The evaluations are related to the contents.
x49	I find information on the platform to organize my study.
x50	Among colleagues we support each other to carry out the work.
x51	The chat exchange with my classmates helps me in my learning.
x52	I know most of my classmates with whom I share study material.
x53	When I am in the chat with my classmates I do some task related to the subject.
x54	The time I spend chatting with my classmates is to discuss the topic of study.
x55	The participation of my classmates in the forum helps me understand the topic of study.

x56	The members of the course collaborate to solve the activities.
x57	Course members, in general, actively participate to learn.
x58	When I have difficulty understanding the content I receive support from my classmates.
x59	*Online* classes are more suitable for students to learn effectively from home.
x60	The online learning system is very effective and helps the students.
x61	Live virtual contact allows teachers to better explain concepts.
x62	Online teaching allows students better study at home.
x63	I have improved my independent learning ability because of this course.

Source: own elaboration

Analysis of data

Measurement and structural model confirmation method

First, the lack of collinearity between the variables was analyzed; In this sense, correlations of .85 or higher indicate multicollinearity (Pérez *et al*., 2013). The first way to validate the measurement model and quantify the construct validity was through an item reliability analysis: confirmatory factor analysis (CFA) (Moafian et al.*,* 2019). The CFA evaluates a theoretical model (Goretzko *et al*., 2023; Hair *et al*., 2018) that is preceded by preliminary theoretical models (Schumacker and Lomax, 2016); Its purpose is to measure the adequacy and/or validity of the instrument's indicators. In this study, the instrument was made up of 62 items. For its part, Kyriazos (2018) recommends a minimum of 100 people for the implementation of the CFA, which was met when working with a sample of 196 students.

Regarding the validity of the items, those that show a factor loading (λ) of at least 0.6 in the reflective constructs were maintained. Subsequently, internal consistency is achieved with Cronbach's alpha (α), which must be greater than .7 to represent good reliability of the scale. This assesses the extent to which the observed variables measure the construct (Gefen and Straub, 2005). Additionally, a composite reliability of 0.5 or more is required for each factor.

Subsequently, the validity of the construct is calculated, through convergent validity and discriminant validity, which complete the construct validity (Cheung *et al*., 2023). Convergent validity examines whether the items designed to quantify a notion effectively

evaluate the same thing. This demonstrates that the fit of the items shows statistical significance and that the items are strongly and significantly correlated (Ahmad *et al.*, 2016). Convergent validity is tested with the analysis of average variance extracted (AVE), which accounts for the variance between the construct and its indicators. Convergent validity is certified when a latent variable and its items share a portion of variance in common; Furthermore, the items are significantly related (Anis *et al.*, 2020). Reflective latent variables must demonstrate a composite reliability greater than 0.6 (Ahmad *et al.*, 2016).

Regarding discriminant validity, Cheung *et al.*, (2023) mention that this contributes to differentiating one factor from another. To measure the discriminant validity of a construct, the square root of the AVE of the construct must be greater than the correlations between the construct and the rest of them (Gefen and Straub, 2005).

The CFA uses goodness-of-fit indices to corroborate whether the structure achieved corresponds to the structure originally stated (Goretzko *et al.*, 2023; Xia and Yang, 2019). Ideally, the χ^2 of the model should be non-significant (Goretzko *et al.*, 2023) to reject the Ho: No significant difference is found between the empirical and theoretical models. As χ^2 is a statistic susceptible to sample size, the following goodness-of-fit indices (Tucker-Lewis index, TLI), the comparative fit index (CFI), and the root mean square index were also considered of approximation error (RMSEA). The CFI indicator and the IFI indicator with values close to one mean a good fit (Martínez, 2021). An RMSEA with values between the range 0.05 to 0.08 show a high degree of acceptance (Ho, 2006). Finally, the estimated model is presented.

Results

Measurement model

In this study, the measurement model analyzed was made up of five constructs: PPT, TSISL, ILMVE, DIC and PAVC. In this section, the reliability of the measurement model was examined with the objective of reviewing whether the items or variables observed appropriately measured the theoretical constructs of the model.

Item reliability

No multicollinearity was detected between the variables because all correlations are bivariate and polychoric, less than 0.85 (results not shown). The confirmatory factor analysis presented an acceptable structure (Khairi and Sukono, 2021), with loadings exceeding .7; those items with lower values were eliminated, since theoretically they are not grouped into the corresponding factor. The values of the main adjustment indicators: $X^2 = 656.357$, $p = .064$; CFI = .915; TLI = .905, RMSEA = .065 are observed within acceptable limits (Blunch, 2008; Khairi and Sukono, 2021) (table 3).

Table 3. Loadings and cross-loadings between the constructs.

item	PPT	TSISL	ILMVE	DIC	PAVC
x1	*0.761*	0.417	0.489	0.463	0.403
x2	*0.782*	0.429	0.502	0.476	0.414
x3	*0.815*	0.447	0.523	0.496	0.431
x4	*0.824*	0.452	0.529	0.502	0.436
x29	0.352	*0.643*	0.587	0.451	0.213
x30	0.421	*0.768*	0.701	0.539	0.255
x31	0.441	*0.805*	0.735	0.565	0.267
x32	0.411	*0.750*	0.685	0.527	0.249
x33	0.370	*0.675*	0.616	0.474	0.224
x34	0.392	*0.715*	0.653	0.502	0.237
x35	0.398	*0.726*	0.663	0.510	0.241
x36	0.421	*0.769*	0.702	0.540	0.255
x37	0.425	0.604	*0.662*	0.453	0.209
x40	0.464	0.659	*0.722*	0.494	0.227
x41	0.494	0.703	*0.770*	0.527	0.243
x42	0.487	0.692	*0.758*	0.518	0.239
x43	0.434	0.617	*0.676*	0.462	0.213
x44	0.503	0.716	*0.784*	0.536	0.247
x45	0.484	0.688	*0.754*	0.516	0.238

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Investigación y el Desarrollo Educativo
ISSN 2007 - 7467

x46	0.438	0.624	*0.683*	0.467	0.215
x47	0.384	0.442	0.431	*0.630*	0.303
x50	0.377	0.435	0.423	*0.619*	0.298
x51	0.496	0.572	0.557	*0.815*	0.392
x52	0.454	0.523	0.510	*0.745*	0.358
x53	0.439	0.506	0.493	*0.721*	0.347
x58	0.364	0.228	0.217	0.331	*0.688*
x59	0.416	0.261	0.248	0.379	*0.787*
x60	0.449	0.282	0.267	0.408	*0.849*
x61	0.470	0.295	0.280	0.428	*0.889*

Source: own elaboration

Internal consistency

In relation to internal consistency, all Cronbach's alpha coefficients are greater than 0.8. The results also show that the composite reliability is greater than 0.8 in all the latent variables, which confirms the internal consistency in the measurement models (table 4) .

Table 4. Internal consistency indices for each construct.

Indices	PPT	TSISL	ILMVE	DIC	PAVC
Composite Reliability	0.872	0.894	0.881	0.829	0.880
Cronbach's alpha	0.872	0.903	0.900	0.825	0.877

Source: own elaboration

Convergent and discriminant validity

In relation to convergent validity, the model showed acceptable values greater than 0.6 in the composite reliability index in the five dimensions (table 4).

Regarding discriminant validity, in most of the constructs the square root of the AVE is greater than the correlations, which corroborates the discriminant validity (table 4), except for IAA with IM, IAA with ID. However, discriminant validity is also assessed by examining the cross-loadings of the indicators in the model (Table 5); each indicator must present the

highest load on the construct it intends to measure (Henseler *et al*., 2015). In this research, cross loadings confirm the existence of discriminant validity.

Table 5. Discriminant validity analysis matrix

|	PPT	TSISL	ILMVE	DIC	PAVC
PPT	0.795				
TSISL	0.548	0.734			
ILMVE	0.642	0.913	0.722		
DIC	0.609	0.702	0.684	0.701	
PAVC	0.529	0.332	0.315	0.481	0.804

Note: Diagonal: root of AVE, lower triangle: correlations between constructs

Source: own elaboration

Hypothesis testing in the structural model

Once the measurement model has been verified, the structural model is examined, that is, the *path coefficients* that establish the relationship between the constructs to determine if the empirical data support the theory. In the contrast of the proposed hypotheses, the *path coefficients* and their significance are evaluated (table 5). The model presents a good fit to the data with indices within the acceptable limits X^2 = 704.437, p = .041; CFI = .91; TLI = .9, RMSEA = .064, are observed within acceptable limits (Blunch, 2008; Cea, 2004; Khairi and Sukono, 2021) (figure 2).

Figure 2. Estimated structural model of the factors that influence the Perceived advantages of virtual classes.
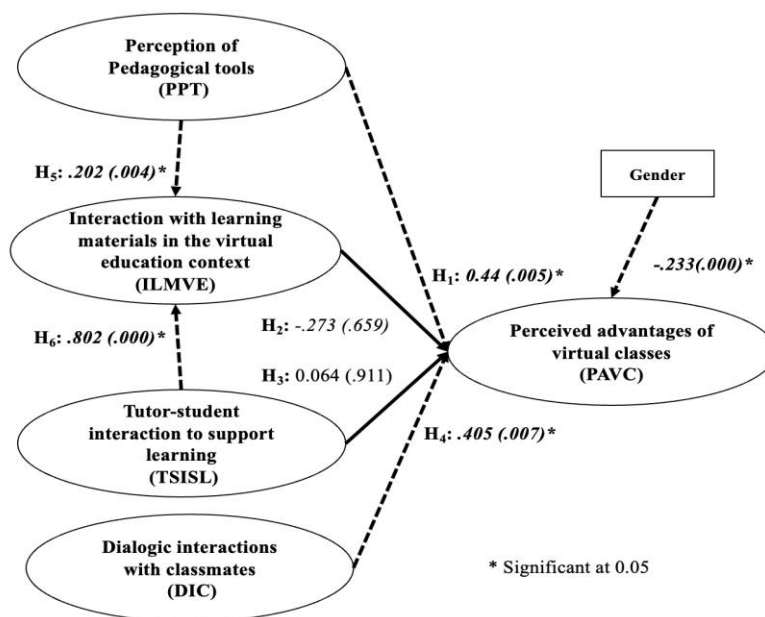
Source: own elaboration

The results of Table 6 indicate, with exception of H2 and H3, the coefficients of the formulated hypotheses confirm the expected sign (positive) and are significant at 0.05. According to the results, the perception of pedagogical tools and dialogic interaction with classmates positively and significantly affect the appreciation of the advantages of virtual courses. In fact, appreciation of pedagogical tools is the factor that most influences the impression of the advantages of online classes. In this sense, the Tutor-student interaction to support learning show a positive effect, as expected, but its effect was not significant. On the other hand, the Interaction with learning materials in the virtual education context showed a negative effect contrary to what was expected, but it was not significant.

Finally, the results indicate that the perception of pedagogical tools positively and significantly affects the material learning interactions of the virtual environment. In addition, it was also confirmed that Tutor-student interaction to support learning contribute positively and significantly to the material learning interactions of the virtual environment (table 6). All standardized loadings per construct are significant and greater than .7 (Table 7).

Revista Iberoamericana para la
Investigación y el Desarrollo Educativo
ISSN 2007 - 7467

Table 6. *Path* coefficients of the proposed structural model

Hypothesis	Standardized coefficient	p value	Result
H1: PPT positively influences PAVC	0.44	0.005*	Not rejected
H2: TSISL positively influences PAVC	0.064	0.911	It is rejected
H3: ILMVE positively influence PAVC	-0.273	0.659	It is rejected
H4: DIC positively influences PAVC	0.405	0.007	Not rejected
H5: PPT positively influences ILMVE	0.202	0.004*	Not rejected
H6: TSISL positively influence ILMVE	0.802	0.000*	Not rejected

Source: own elaboration

Table 7. Constructs with their standardized loads

Construct	Variable	Standardized load	p value
PPT	x25	0.761	
	x26	0.781	0.000
	x27	0.813	0.000
	x28	0.825	0.000
TSISL	x31	0.643	
	x32	0.767	0.000
	x33	0.806	0.000
	x34	0.749	0.000
	x36	0.674	0.000
	x37	0.714	0.000
	x38	0.728	0.000
	x39	0.771	0.000
ILMVE	x41	0.662	
	x42	0.722	0.000
	x43	0.77	0.000
	x44	0.758	0.000

	x46	0.677	0.000
	x47	0.784	0.000
	x48	0.753	0.000
	x49	0.683	0.000
DIC	x51	0.633	
	x53	0.618	0.000
	x56	0.814	0.000
	x57	0.747	0.000
	x58	0.718	0.000
PAVC	x59	0.696	
	x60	0.794	0.000
	x61	0.857	0.000
	x62	0.892	0.000

Source: own elaboration

Indirect and total effects

In addition to examining the direct effects of PHO, ILMVE, TSISL, and DIC on PAVC, the indirect effects of PPT and TSISL through ILMVE, as well as their total effects, were also evaluated. Table 8 shows the indirect and total effects of the structural model. The indirect effect of TSISL on PAVC was not significant (estimator = -0.374, p-value = 0.239). The indirect effect of PPT on PAVC was also not significant (estimator = -0.069, p-value = 0.319).

Regarding the total effects, statistical significance was only observed regarding the total effect of PPT on PAVC (estimator = 0.480, p value = 0.000). Compared with the direct effect of PPT on PAVC (estimator = 0.440, p-value = 0.005), it can be appreciated that both are positive and similar in magnitude.

Table 8. Direct and indirect effects of the proposed conceptual model

Indirect effects	Estimator	p value
TSISL ILMVE PAVC	-0.374	0.239
PPT ILMVE PAVC	-0.069	0.319
Total effects		
TSISL	-0.041	0.832
PPT	0.480	*0.000*

Source: own elaboration

To help understand the previous results, the structural model analyzed is shown graphically (Figure 2), with the *path coefficients* and their significance.

Discussion

In recent years, information technologies have acquired an outstanding role due to the confinement situation that has been imposed due to the COVID-19 pandemic. The consequences and demands have involved various areas, including the educational sector, which has required a great effort from both teachers and students, since there has been the need to develop and use web pages and technological platforms to continue with academic work.

On the other hand, given that distance education has spread substantially, it is essential to identify the criteria required for student progress in technology-assisted educational environments (Berridi et al., 2015). Based on the results, it is corroborated—as demonstrated by Salgado (2015) and Almahasees *et al*. (2000)—that perceiving information and communications technologies as dynamic, accessible, simple and flexible are the factors that most influence when students express the existence of advantages of virtual courses; mainly regarding being more suitable for learning effectively from home, as an effective and helpful system, as well as the fact that live virtual contact promotes a better explanation of concepts.

Similarly, what was stated by Berridi *et al.* (2015), was corroborated. Sánchez and García (2019) and Barberá-Gregori *et al*. (2021) regarding the existence of a direct relationship between dialogic interaction with classmates and the perceived advantages of virtual classes. This shows that perceiving advantages in the ICT used in a private university in Guadalajara, in the state of Jalisco, Mexico, also depends largely on students appreciating

that the exchange in chats allows them to carry out tasks and helps them in their learning, as well as feeling that collaboration, active participation and support among peers helps solve activities.

However, when examining the present relationship between learning material interactions in the virtual environment and the perception of advantages of virtual courses proposed by Juca (2016) and Alcivar *et al*. (2022), a non-significant relationship was detected, which denotes that even when students appreciate the ease of understanding and sufficient content of the materials, the diversity of formats in the contents, the convenience of the activities, the adequate relationship of contents. with the evaluations, and that the content of the platform allows the organization of the study, this does not imply additional benefits of taking online classes. The above may be due to what has already been established by Mora-Vicarioli and Hooper-Simpson (2016) that what is truly relevant in virtual learning environments is collaborative work.

The interaction with the advisor to support learning also justifies the appreciation of the advantages of online courses (Berridi *et al*., 2015; Copari, 2013; Sánchez and García, 2019). However, research has shown that even when the teacher supports, advises, provides feedback, motivates and promotes reflection through messages and forums, this does not necessarily lead to a perception of advantages of online courses. It seems that for the student, his perception in relation to the pedagogical tools is more relevant. A possible explanation is related to the nature of the student, that is, if they are a digital native or immigrant, their disposition may fluctuate.

Likewise, it can be noted that a positive perception of pedagogical tools stimulates an also positive opinion about the material learning interactions of the virtual environment, which coincides with what was proposed by Varguillas and Bravo (2020). Additionally, what was established by Moreira (2019) was confirmed that a positive appreciation of the Tutor-student interaction to support learning causes a favorable evaluation of the material learning interactions of the virtual environment.

On the other hand, the *laptop* was the most reported device used to connect to virtual classes, while the most used platforms during the pandemic were Whatsapp, followed by Teams, Moodle and Zoom. The most used social network was WhatsApp.

Finally, one of the restrictions of the study was the exclusive orientation on the student's perspective. Another limitation was the specific sample of a single university in the city of Guadalajara; in this sense, considering various universities in the future would be a

way to increase the robustness of the study. Regarding the last limitation, a non-probabilistic sampling stands out, so it is not possible to generalize the results to other samples.

Conclusions

It is recommended to identify the skills of both students and teachers in the management of technologies, to design training plans, so that the tools can be efficiently applied and performance in the management of the Internet and essential platforms in online instruction is increased. line. In this way, effective communication could be achieved between the parties through said technologies. Additionally, it is advisable to refine and refine the virtual teaching materials, since the predominance of the visual learning style was confirmed.

On the other hand, the findings corroborated what was reported in the literature about the enriching experience represented by both the virtual academic forum and the online evaluations. In this sense, forums encourage asynchronous student participation, and promote a favorable stance towards online classes. In accordance with this idea, it was perceived that participatory work in online courses is essential due to the constant use of new technologies and the diversity of the teaching models used.

Finally, this study showed that students' attitudes towards ICT vary depending on whether they were digital natives or immigrants. As already mentioned, digital natives find it easier and more familiar to use ICT, which implies an advantage for teachers who use it in their classes. However, digital immigrants face technological limitations, which represents a challenge for teachers, hence they will have to devise strategies to encourage the use of ICT and seek a change in attitude.

Future lines of research

Given that in this research the vast majority reported the visual learning style, followed by the kinesthetic and in some cases the auditory, it is recommended in future research to optimize the design of virtual teaching materials so that they adapt to the characteristics of the students. .

Furthermore, it is proposed to investigate whether the students' environment encourages them to share, negotiate, debate or exchange knowledge, since it is considered that the learning environment can foster a more attractive scenario for online classes. That is,

the relationship between the learning climate and student motivation must be empirically and statistically examined. Finally, it is recommended to know the opinion of teachers regarding these new teaching and learning scenarios.

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