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Artículos científicos

Percepción estudiantil universitaria de los cursos en línea implementados por contingencia covid-19. Un modelo de ecuaciones estructurales

University Student Perception of Online Courses Implemented by COVID-19 Contingency. A Model of Structural Equations

Percepção de universitários sobre cursos online implementados devido à contingência da covid-19. Um modelo de equação estrutural

Salustia Teresa Cano Ibarra
Tecnológico Nacional de México, México
teresa.cano@itcelaya.edu.mx
https://orcid.org/0000-0001-7165-4106

María Teresa de la Garza Carranza
Tecnológico Nacional de México, México
teresa.garza@itcelaya.edu.mx
https://orcid.org/0000-0002-4877-3403

José Porfirio González Farías
Tecnológico Nacional de México, México
porfirio.gonzalez@itcelaya.edu.mx
https://orcid.org/0000-0002-5859-6340

Patricia Galván Morales
Tecnológico Nacional de México, México
patricia.galvan@itcelaya.edu.mx
https://orcid.org/0000-2619-6115

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Resumen

El objetivo de esta investigación fue validar el modelo de percepción de estudiantes universitarios sobre la educación en línea que se desarrolló de manera emergente por la situación de pandemia de covid-19. Se trató de un estudio cuantitativo que incluyó un análisis factorial exploratorio (AFE), el cual arrojó tres factores que explican 71 % de la varianza. La consistencia interna de la escala fue adecuada: un alfa de Cronbach de 0.938. Con la finalidad de ratificar el modelo obtenido en el AFE, se llevó a cabo un análisis factorial confirmatorio (AFC) en el que participaron 595 estudiantes de licenciatura del Tecnológico Nacional de México en Celaya divididos en dos grupos. Los resultados indican que el modelo de ecuaciones estructurales final cumple con todos los índices de ajuste y, por ende, que el instrumento final de medición es estable. A partir del modelo validado, se pudo asegurar que, según la percepción de los estudiantes, no se tuvieron grandes problemas en adaptarse a los cursos en línea y no se detectaron problemas graves de conectividad y tecnología, pero extrañan la interacción con profesores y compañeros. Además, manifestaron que la manera en que el profesor diseñe y desarrolle el curso es fundamental para el logro de su éxito académico y consideraron que la retroalimentación del profesor es una acción muy valiosa que fortalece el conocimiento.

Palabras clave: análisis factorial confirmatorio, análisis factorial exploratorio, ecuaciones estructurales, evaluación del aprendizaje en línea.

Abstract

The objective of this research was to validate the perception model of university students about online education that was developed in an emergent way due to the COVID-19 pandemic situation. It was a quantitative study that included an exploratory factor analysis (EFA), which yielded three factors that explain 71% of the variance. The internal consistency of the scale was adequate: a Cronbach's alpha of 0.938. To ratify the model obtained in the EFA, a confirmatory factor analysis (CFA) was carried out in which 595 undergraduate students from the Tecnológico Nacional de México in Celaya participated, divided into two groups. The results indicate that the final structural equation model complies with all the fit indices and, therefore, that the final measurement instrument is stable. Based on the validated model, it was possible to ensure that, according to the students' perception, there were no major problems adapting to online courses and no serious connectivity and technology

problems were detected, but they miss interacting with teachers and classmates. In addition, they stated that the way in which the teacher designs and develops the course is fundamental to achieving their academic success and they considered that the teacher's feedback is a very valuable action that strengthens knowledge.

Keywords: confirmatory factor analysis, exploratory factor analysis, structural equations, online learning assessment.

Resumo

O objetivo desta pesquisa foi validar o modelo de percepção de estudantes universitários sobre educação online que foi desenvolvido de forma emergente devido à situação de pandemia de covid-19. Foi um estudo quantitativo que incluiu uma análise fatorial exploratória (AFE), que resultou em três fatores que explicam 71% da variância. A consistência interna da escala foi adequada: alfa de Cronbach de 0,938. Para ratificar o modelo obtido no AFE, foi realizada uma análise fatorial confirmatória (CFA) na qual participaram 595 estudantes de graduação do Instituto Tecnológico Nacional do México em Celaya, divididos em dois grupos. Os resultados indicam que o modelo de equação estrutural final atende a todos os índices de ajuste e, portanto, que o instrumento de medida final é estável. Com base no modelo validado, foi possível garantir que, na percepção dos alunos, não houve grandes problemas de adaptação aos cursos online e não foram detectados problemas graves de conectividade e tecnologia, mas sentem falta de interação com professores e colegas. Além disso, afirmaram que a forma como o professor concebe e desenvolve o curso é fundamental para alcançar o seu sucesso académico e consideram que o feedback do professor é uma ação muito valiosa que fortalece o conhecimento.

Palavras-chave: análise fatorial confirmatória, análise fatorial exploratória, equações estruturais, avaliação da aprendizagem online.

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Introduction

As a result of the pandemic generated by the 2019 coronavirus disease (covid-19), educational institutions were forced to implement online education strategies in order not to miss the semester or school year. Higher education institutions were no exception. Given the possibility of continuing with this modality, it becomes essential to evaluate the online courses and thus take the corresponding actions to improve and enrich them. To measure this perception, it is essential to have reliable and valid scales. The present study sought to test an instrument generated under an intense theoretical search in order to provide evidence about reliability and make its possible standardization feasible. It was applied to undergraduate students of the National Technological Institute of Mexico (TecNM) Celaya.

The TecNM is a higher education system that was founded in 1948 as a deconcentration of the National Polytechnic Institute (IPN). Currently, it has more than 250 campuses throughout the national territory, including Celaya. The TecNM offers bachelor's, master's and doctoral degrees in the areas of engineering and administrative economic sciences. The TecNM offers the educational service in person; however, in March 2020, due to the aforementioned health contingency, and on instructions from the Ministry of Public Education (SEP), it was necessary to move the courses to virtuality. Although little by little it has been returning to normality, the possibility of keeping social distance again is still latent, so this research seeks to develop an evaluation instrument for online classes, but taking into account the conjunctural aspects of the present. and with it effectively measure the perception of students about the courses.

The instrument was built and adapted to the sociocultural context of the students by research professors from the Department of Economic and Administrative Sciences of the TecNM, using as the main basis the evaluation instruments of online courses of Cidral, Oliveira, Di Felice y Aparicio (2018), Dziuban, Moskal, Kramer y Thomson (2012), Flores and López (2019), Robert, Irani, Telg y Lundy (2005), Palmer y Holt (2009) y Zambrano (2016).

The instrument developed was subjected to an exploratory factor analysis (EFA) in order to give statistical justification to the constructs and remove those items that did not provide significant information. Subsequently, a confirmatory factor analysis (CFA) was carried out through structural equations to confirm the dimensions identified in the EFA, which gave way to the proposed structural equation model.

Theoretical framework

The need to evaluate online courses arises from the popularity of this type of tools, which have been designed to develop skills and competencies in the student through the use of computer platforms. However, the concept of online course evaluation is not yet fully defined in the literature. (Marciniak y Gairín, 2018).

> Evaluating a virtual distance education program should shift the student's gaze to the teaching proposal in the virtual context, to the communication process in teaching and learning and to the interaction based on the demands and collaborative processes that are organized. (Fainholc, 2004, p. 4).

In the world online education is becoming more and more popular. This can range from training courses to undergraduate and postgraduate university courses. Online education helps reduce the spatial barriers that exist in face-to-face learning. In general, it is considered that online learning can be both synchronous (real-time interaction) and asynchronous (free interaction), which gives flexibility to the needs of the student enrolled in this type of learning (Panigrahi, Srivastava and Sharma, 2018). Although there are several problems associated with this type of modality, there are more arguments in favor of online learning, including cost (Butler, Haldeman and Laurans, 2012).

Kebritchi, Lipschuetz and Santiague (2017) describe some success factors for online courses:

Course content

Due to the fact that in online classes the content must be predefined, the creation of interaction spaces is limited. This does not help the instructor to convey their experiences effectively (Baran, Correia, & Thomson, 2011). This causes the courses to be decontextualized. The teacher must develop strategies so that the course is not only in content and also includes enriching experiences. New remote collaborative work tools can help improve the learning experience.

Multimedia

Courses must integrate multimedia content. Sites like YouTube can be used to support learning. Games and simulators can also be included, as well as Internet searches. The learning experience is enhanced if a variety of instructional sources are sought (Kyei, Godwyll, & Keengwe, 2011). The new tools that are being developed such as Google

Classroom and Teams allow multimedia activities to be managed by teachers. This allows student learning to develop in a more flexible and organized way.

Instructional Strategies

The student must be the center of learning, so the designed activities must be focused to achieve this goal. The content must include collaborative and individual activities that have assessment rubrics so that the student understands specifically what is wanted from each assignment. According to Niess and Gillow (2013), best practices should include collaborative activities, reflective activities, evaluation criteria, as well as technology integration.

Curriculum development

From the beginning to the end, the course must be sectioned into units according to the learning content. The sections must be significant for the student, either due to thematic content or due to evaluation objectives. The clarity of the assignments is very important so that the student can understand what is asked of him and thus be able to plan his time (Allen, Kiser and Owens, 2013). The formative and summative evaluations will provide evidence of the learning of the course, for which they must be planned so that they evaluate the learning units.

Despite the challenges posed by online education, lately it has become very important in Mexico and around the world. During the covid-19 pandemic, according to the Internet Mx Association (2021), 65% of the people who studied in the face-to-face or mixed modality continued studying by video call and the rest by platform; only 28% of teachers were considered highly qualified and 38% somewhat qualified, and 37% of students paused their studies due to time, lack of money and health issues . In addition, according to this study, students are more interested in the options that involve online study (mixed or totally online) and they put the flexibility of schedules, study plan and costs as an advantage. The previous results indicate that this modality should be a priority in the higher education system in the 21st century. And with this, it is also essential to evaluate this modality to ensure the effectiveness and quality of its courses (Martin, Ndoye and Wilkins, 2016). Of course, the experience of the student must be considered (Gómez, Barberá and Férnandez, 2016).

Institutions that offer online education must consider in the design of their courses, not only its quality and execution, but also the student's experience. (Gómez *et al.*, 2016).

This research is based on various empirical studies, including that of Robert et al. (2005), who used nine dimensions in their research: 1) Student-teacher interaction, 2) Student-student, 3) Student-content, 4) Instructor, 5) Course organization, 6) Service support, 7) Facilitator , 8) Technical support and 9) Methods. While in the research conducted by Dziuban et al. (2012) several dimension options were analyzed and it was concluded that the best ones are the following four: 1) Pace of the course, 2) Rules, 3) Instructor commitment and 4) Progress.

To evaluate the online courses of the University of Montenegro, Scapanovic and Bauk (2014) used a model based on four dimensions: 1) Interface, 2) Communication, 3) Forms of evaluation and 4) Instructions and materials. Instructions and materials was the dimension that the students considered most important, followed by Interface, Communication and, finally, Forms of evaluation.

An interesting investigation was developed by Palmer and Holt (2009) at Deakin University, in Victoria, Australia, during the years 2005 and 2006. As part of this, it was forced to include at least one unit in all the subjects of all its undergraduate programs. with the intention of analyzing the correlation of the variable "Student satisfaction in online learning" and the variables: 1) Organization and structure, 2) Teaching and learning, 3) Interaction with teachers and students, 4) Evaluation, 5) Attribute Development and 6) Unit Performance. The instrument they applied had 40 items and the results, after applying a multivariate analysis, surprisingly showed the researchers that the lowest scores were related to online interaction with teachers and other students and the variables of highest satisfaction were related to with activities, organization and access to digital resources. Finally, the study concludes that the student finds satisfaction in online learning as long as there is a good structure of the course that includes activities that allow interaction, well-defined evaluation actions and timely feedback from teachers.

In an investigation on the approach of which are the best determinants that affect the learning and performance of students in virtual courses developed by Zambrano (2016), the dimensions 1) Students were used, with three factors: "Attitude towards computers" , “Anxiety about the use of computers” and “Self-efficacy in the use of the Internet”; 2) Teachers, with the factors: "Timely response" and "Teacher's attitude"; 3) Course, with the

factors "Flexibility" and "Quality"; 4) Technology, with the factors "Technological quality" and "Internet quality"; 5) Design, with the factors "Utility of the virtual system" and "Ease of use". virtual system"; 6) Environmental, with the factors "Evaluation diversity" and "Interaction with other students". As a result, it was obtained that, with the exception of "Anxiety about the use of computers", which had a negative correlation, all the Other factors registered positive correlations and predict a direction of student satisfaction.

In Brazil, Cidral et al. (2018) proposed a model to evaluate user satisfaction in the use and impact of the e-learning modality in which they integrate the dimensions quality in collaboration, quality of information, quality of the system, attitude of the instructor, diversity in the evaluation and interaction with the students, the model is validated using structural equations, finally generating an instrument of 37 items, and within the results they show that the use and user satisfaction are interdependent and both have a positive impact on performance individual. They also find that the platforms must have an environment of collaboration and communication, as well as the contents and diversify the forms of evaluation to be acceptable to the students.

In a recent study carried out by Garris and Fleck (2020) in various universities in the United States in relation to online courses, and from a multifactorial perspective (personal characteristics and characteristics of the course), it was found that professors were not prepared to face the situation caused by covid-19. The main findings of his empirical study applied to 429 students were that the students perceived a lower quality in the courses, they found them less pleasant, less interesting, with less learning and in general the student felt less involved in the process. The study reveals that students did not want to take the courses online, which could affect their perspective of the quality of the course.

From Portugal, Oliveira, Mesquita, Sequeira and Oliveira (2021) found a better scenario than expected, since the negative impacts of distance education had been less. The authors of the study argue that since technology is a resource widely used by the generation of millennials and centennials, the transition to virtual education was not so abrupt. Thus, the emergency, and specifically the change from face-to-face to remote that it brought with it, did not seem to affect this type of student because they already had a technological background. The negative impacts were found mainly at two levels: the management of class work (socio-educational interactions) and psychological well-being. Despite having all the necessary educational resources, students lack social interaction with teachers and classmates

and report little personal involvement on the part of teachers. In addition, distance education is noticeably more tiring from their point of view and not as satisfying. Consequently, students feel less optimistic about their academic success and less interested in pursuing online learning in the future. The issue of remote online education is an aspect that will generate discussion among researchers, since the pandemic does not yet have an end date and studies will continue to appear.

In Mexico there are also investigations in this regard. Such is the case of the one undertaken by Flores and López (2019), who used five dimensions: 1) Pedagogical, 2) Technological, 3) Interface design, 3) Evaluation, 4) Management and 5) Orientation. These researchers used the dimensions based on the empirical studies of Khan (2015), and obtained as conclusions that the students of the Centro Universitario del Sur, belonging to the University of Guadalajara, in general evaluated the courses in an acceptable way, but that there are criteria that are urgent to improve, among them, paying special attention to the clarity of the activities, the student-teacher interaction, the format of the educational content, the feedback of the activities, the timely attention and the teacher's attitude.

Methodology

The present project is a quantitative and cross-sectional investigation that sought the validation of the proposal of an empirical construct and whose bases are the AFE and the AFC. In order to achieve the objective of validating the model of perception of university students about online education that was developed in an emergent way due to the covid-19 pandemic, once the questionnaire was completed, a pilot test of the questionnaire was carried out taking into consideration a group of 250 students from all semesters and careers. The results were satisfactory, therefore, a survey was carried out in the student population.

At the date of the study, TecNM Celaya had 6,830 students divided into 10 degrees. Of this total, 595 students participated in the study: 47.2% were men (281) and 52.8% women (314). Students from all careers were considered: engineering in Business Management (138), Mechatronics (104), Chemistry (88), Biochemistry (56), Computer Systems (53), Industrial (47), Mechanics (22), Electronics (11), Environmental (5) and a degree in Administration (71). The sample included students from all semesters, from the first to the tenth.

The steps followed to validate the questionnaire were the following: 1) Calculation of descriptive statistics of the questionnaire, 2) AFE and 3) AFC of first and second order. The AFE is a multivariate method whose objective is to reduce the number of variables to a common factor. To determine the adequacy of the EFA test, the Kaiser, Meyer, Olkin (KMO) sample adequacy measure was calculated, which tests whether the partial correlations between the variables are very small. It allows you to compare the magnitude of the observed correlation coefficients with the magnitude of the partial correlation coefficients. The KMO statistic has values between zero and one. Small values indicate that factor analysis is not adequate.

In the next phase, a first-order CFA was performed through the structural equation model using the Mplus version 7 software. The CFAs allow to compare if the data is consistent with the theory. To avoid inconsistencies in the normality of the data, the robust maximum likelihood method (MLR) proposed by Satorra and Bentler (1994) was used. The MLR method represents an improvement of the AFE performed in SPSS software that provides more accurate results. The second order CFA allows us to compare the parameters and integrate the proposed model in a single factor.

Procedure

The instrument was generated using the Google Form tool. It was disclosed for your response in the Institute's Comprehensive Information System and in its social networks. The students answered anonymously and the confidentiality of the data was taken care of at all times. The responses were processed using SPSS version 22 and MPLUS v.7 software.

To verify the connectivity and computing resources they have, an additional question was asked in this regard. And as a result, it was obtained that 93% have internet in their homes, 72% have at least one laptop, 20% have a desktop computer, 12% have a tablet, 93% have a cell phone with internet access and 100% have at least one resource. This shows us that there was no absence of computer resources or connectivity.

Instrument

The applied instrument is presented in Table 1. It consists of a 23-item Likert-type questionnaire with a range from one to seven points, ranging from “Totally disagree” to “Totally agree”.

Tabla 1. Instrumento para medir percepción de clases en línea

Dimensión	Autor	Ítem
Interacción estudiante-maestro (EM)	Robert *et al.* (2005)	EM1. Los maestros estaban disponibles cuando fue necesario
	Zambrano (2016)	EM2. Existió atención oportuna del profesor cuando lo necesité
	Dziuban *et al.* (2012)	EM3. La retroalimentación de los profesores fue oportuna
	Scapanovic (2014)	EM4. El material de apoyo que envió el profesor fue pertinente
	Zambrano (2016)	EM5. Los profesores utilizaron diversidad de actividades
	Zambrano (2016)	EM6. El profesor tuvo un trato cordial y respetuoso
Interacción estudiante-estudiante (EE)	Robert *et al.* (2005)	EE1. Me fue posible contactar a mis compañeros cuando lo necesité
	Cidral *et al.* (2018)	EE2. Hubo una sensación de comunidad entre los estudiantes durante el curso
	Robert *et al.* (2005)	EE3. Se facilitó el aprendizaje entre grupos de compañeros a través de interacción remota (Whatsapp, chats, etc.)
	Cidral *et al.* (2018)	EE4. Se facilitó la comunicación e intercambio de información entre los compañeros
Organización del curso (OC)	Dziuban *et al.* (2012)	OC1. Los objetivos de los cursos fueron claros
	Scapanovic (2014)	OC2. Las instrucciones del curso fueron claras
	Zambrano (2016)	OC3. El tiempo establecido para realizar las actividades del curso fue suficiente
	Cidral *et al.* (2018)	OC4. La evaluación de las actividades del curso fue justa y oportuna

	Robert *et al.* (2005)	0C5. El aprendizaje que se adquirió fue menor al de un curso presencial
Interacción con la plataforma (IP)	Flores y López (2019)	IP1. La disponibilidad y funcionalidad del internet fue oportuna
	Zambrano (2016)	1P2. La disponibilidad y navegación en las plataformas utilizadas fueron oportunas y convenientes (classroom, teams, zoom, schoology, etc.)
	Cidral *et al.* (2018)	IP3. La interacción con el profesor a través de la plataforma fue de animación y motivación
	Zambrano (2016)	IP4. Los recursos adicionales para complementar el curso fueron oportunos y convenientes (Youtube, Scholar Google, correo electrónico, etc.)
Dimensión individual en línea (IL)	Robert *et al.* (2005)	IL1. Me concentro más fácilmente en mis cursos en línea
	Zambrano (2016)	IL2. Mi experiencia en línea facilita acceder a material adicional por mi cuenta
	Zambrano (2016)	IL3. Manejo mi propio aprendizaje en un curso en línea
	Zambrano (2016)	IL4. El trabajo en línea me permite mayor flexibilidad para otras actividades (trabajo, ayudar en casa, etc.)

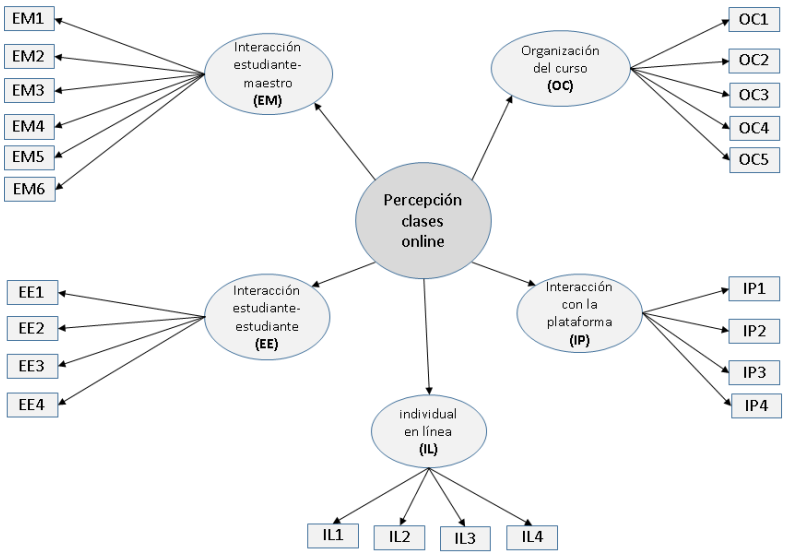
Fuente: Elaboración propia

Figure 1 shows the initial model proposed based on the theoretical review. It includes five dimensions: 1) Student-teacher interaction (EM), with six observable variables; 2) Student-student interaction (EE), with four observable variables; 3) Organization of the course (OC), with five observable variables; 4) Interaction with the platform (IP), with four observable variables and, finally, 5) Individual online (IL), with four observable variables.

The EM dimension seeks to identify the relationship between the two based on the independent variables "Availability", "Attention", "Feedback", "Material", "Diversification of activities" and "Treatment". The EE dimension seeks to identify the relationship between them with the independent variables "Contact", "Community feeling", "Teamwork", "Communication and information exchange". The OC dimension, with the independent

variables "Objectives", "Instructions", "Time to carry out activities" and "Comparison of learning with a face-to-face course". The IP dimension seeks to evaluate the platform used by the teacher with the independent variables "Availability", "Functionality", "Navigation", "Interaction" and "Additional resources". Finally, dimension II aims to measure the individual form of online learning and for this it uses the independent variables "Concentration", "Ease of access", "Self-learning" and "Flexibility with other activities".

Figura 1. Modelo inicial propuesto



Fuente: Elaboración propia

Results

Descriptive results

The descriptive analysis in relation to the mean and standard deviation of all the observable variables is presented in Table 2. There it can be seen that the lowest mean value corresponds to item IL1, “I concentrate more easily in my online courses ”, with a value of 3.51, and the item that presents the highest average value is EM6, with a value of 6.09: “The teacher had a cordial and respectful treatment”. This indicates the empathy of the professors towards the students, who show that it is not easy to concentrate in this modality of the online courses to which they were not accustomed.

Tabla 2. Medidas descriptivas por ítem

Ítem	Media	Desviación estándar	Ítem	Media	Desviación estándar
EM1	5.17	1.425	OC3	4.88	1.672
EM2	5.21	1.428	OC4	5.23	1.412
EM3	4.97	1.457	OC5	5.53	1.500
EM4	5.05	1.419	IP1	4.23	1.745
EM5	5.10	1.565	IP2	5.24	1.407
EM6	6.09	1.183	IP3	4.99	1.462
EE1	5.67	1.366	IP4	5.37	1.339
EE2	5.55	1.395	IL1	3.51	1.791
EE3	5.32	1.484	IL2	5.12	1.409
EE4	5.37	1.351	IL3	5.09	1.382
OC1	5.03	1.417	IL4	4.44	2.015
OC2	5.12	1.431			

Fuente: Elaboración propia

A descriptive analysis by dimension was also carried out. The SE is the dimension that presents the highest mean (5.478) and the lowest standard deviation (1.40) and a Cronbach's alpha of 0.86; followed by the EM interaction, with a mean of 5.266 and a standard deviation of 1.417 with a Cronbach's alpha of 0.916. Dimensions II and IP present the lowest average (4.958 and 4.542) and the highest deviations (1.495 and 1.67). This indicates that teamwork, communication and information exchange among students were mainly facilitated.

Before proceeding with the EFA and in order to assess its viability, the correlation matrix of the items presented in Figure 2 was made. All the correlations between items are statistically significant at $p < 0.01$. The correlations between the items were between 0.2 and 0.8. An internal consistency test was also performed using a Cronbach's alpha reliability analysis, which resulted in 0.928. The KMO sample adequacy index showed a value of 0.85 and Bartlett's sphericity test was significant (1211.18, gl = 136, sig =0.001). These values indicate the relevance of the AFE (Hair, Anderson, Tatham y Black, 2010).

Figura 2. La matriz de correlaciones

	EM1	EM2	EM3	EM4	EM5	EM6	EE1	EE2	EE3	EE4	OC1	OC2	OC3	OC4	OC5	IP1	IP2	IP3	IP4	IL1	IL2	IL3	IL4
EM 1	1.0																						
EM 2	.835	1.0																					
EM 3	.729	.779	1.0																				
EM 4	.658	.683	.695	1.0																			
EM 5	.639	.637	.646	.687	1.0																		
EM 6	.529	.553	.564	.521	.505	1.0																	
EE1	.288	.298	.348	.339	.332	.385	1.0																
EE2	.297	.281	.284	.315	.319	.315	.629	1.0															
EE3	.363	.359	.423	.410	.336	.365	.530	.589	1.0														
EE4	.316	.338	.371	.356	.316	.355	.585	.593	.719	1.0													
OC 1	.629	.644	.666	.708	.640	.526	.363	.370	.460	.426	1.0												
OC 2	.663	.697	.694	.684	.698	.569	.383	.340	.391	.384	.827	1.0											
OC 3	.527	.585	.561	.558	.500	.481	.376	.358	.360	.348	.596	.647	1.0										
OC 4	.574	.594	.600	.602	.532	.553	.381	.336	.408	.353	.598	.641	.666	1.0									
OC5	-.11	-.12	-1.1	-.16	-.13	-.03	-.14	-.04	-.14	-.06	-.19	-.18	-.17	-.08	1.0								
IP1	.332	.356	.308	.366	.264	.330	.328	.321	.316	.318	.397	.362	.427	.341	-.07	1.0							
IP2	.421	.441	.442	.446	.396	.442	.396	.392	.438	.398	.471	.462	.449	.430	-.11	.614	1.0						
IP3	.553	.569	.604	.614	.553	.507	.371	.385	.432	.433	.622	.621	.557	.568	-.12	.449	.512	1.0					
IP4	.542	.542	.521	.575	.555	.460	.365	.433	.468	.355	.616	.605	.522	.550	-.11	.456	.576	.599	1.0				
IL1	.215	.253	.288	.310	.261	.189	.209	.230	.317	.211	.345	.347	.348	.241	-.30	.341	.347	.315	.307	1.0			
IL2	.277	.275	.289	.310	.330	.293	.295	.321	.404	.322	.377	.378	.290	.311	-.13	.304	.405	.399	.462	.521	1.0		
IL3	.197	.204	.238	.233	.279	.227	.215	.246	.251	.193	.271	.256	.201	.204	-.12	.243	.320	.273	.362	.435	.573	1.0	
IL4	.218	.255	.242	.250	.236	.204	.133	.147	.143	.121	.297	.302	.392	.296	-.11	.299	.227	.324	.285	.464	.320	.248	1

Fuente: Elaboración propia

Exploratory factor analysis

Principal components analysis was performed with an orthogonal rotation. Items that did not group in a factor with factor loadings greater than 0.5 or that did not group in a factor that had at least three items were eliminated.

In the final solution three factors showed values higher than one. This solution converged in five iterations and explains 71% of the variance. Table 3 presents the matrix of rotated components. It shows that the items OC5, "The learning that was acquired was less than that of a face-to-face course", and IP2, "The availability and navigation on the platforms used were timely and convenient (classroom, teams, zoom, schoology, etc.)", were eliminated because they were not found within the specified levels.

Tabla 3. Matriz de componentes rotados

Matriz de componente rotado[a]			
	Componente		
	1	2	3
EM2. Existió atención oportuna de los profesores cuando los necesité	0.861		
EM1. Los profesores estaban disponibles cuando fue necesario	0.837		
EM3. La retroalimentación de los profesores fue oportuna	0.829		
OC2. Las instrucciones del curso fueron claras y precisas	0.818		
EM4. El material de apoyo que enviaron los profesores fue pertinente	0.800		
OC1. Los objetivos de los cursos fueron claros.	0.768		
EM5. Los profesores utilizaron diversidad de actividades	0.761		
OC4. La evaluación de las actividades del curso fue justa y oportuna.	0.718		
OC3. El tiempo establecido para realizar las actividades del curso fue suficiente	0.669		
IP3. La interacción con el profesor a través de la plataforma fue de animación y motivación.	0.653		
EM6. Los profesores tuvieron un trato cordial y respetuoso con los estudiantes	0.642		
IP4. Los recursos adicionales para complementar el curso fueron oportunos y convenientes (Youtube, Scholar Google, correo electrónico, etc.)	0.592		
EE4. Se facilitó la comunicación e intercambio de información entre los compañeros		0.819	
EE2. Hubo una sensación de comunidad y apoyo entre los estudiantes durante el curso		0.797	

EE3. Se facilitó el aprendizaje entre grupos de compañeros a través de interacción remota (Whatsapp, chats, etc.)		0.769	
EE1. Me fue posible contactar a mis compañeros cuando lo necesité		0.767	
IL1. Me concentro más fácilmente en mis cursos en línea			0.783
IL2. Mi experiencia en línea facilita acceder a material adicional por mi cuenta			0.731
IL3. Manejo mi propio aprendizaje en un curso en línea			0.711
IL4. El trabajo en línea me permite mayor flexibilidad para otras actividades (trabajo, ayudar en casa, etc.)			0.637
IP1. La disponibilidad y funcionalidad del internet fue oportuna			0.402

Fuente: Elaboración propia

The final instrument was made up of 21 items. With a final Cronbach's alpha of 0.93, and the reduction to three factors: "Organization of the course and student-teacher interaction" (F1), with items EM2, EM1, EM3, OC2, EM4, OC1, EM5, OC4, OC3 , IP3, EM6 and IP4; “Student-student interaction” (F2), with the items EE4, EE2, EE3 and EE1, and, finally, “Individual interaction with the platform” (F3), with the items IL1, IL2, IL3, IL4 e IP1.

Confirmatory factor analysis

To confirm the dimensions identified in the AFE, and in order to ensure the reliability of the instrument, an AFC study was carried out using varimax rotation to explore the relationships between the variables. The model adjusted to three factors was built with the manifest variables mentioned for each construct. In table 4 you can see the results. The goodness of fit of the proposed model, which refers to the accuracy of the model data to determine if it is correct, was evaluated using various indicators: χ^2 (chi squared) divided by the degrees of freedom, the average of the residuals (SRMR), the mean of the standardized residuals (RMSEA), the comparative fit index (CFI). For there to be a good fit, the CFI value

must exceed 0.9, the RMSEA and SRMR values must be close to 0.05, and the χ^2/df coefficient must be less than or equal to three.

Tabla 4. Cargas estandarizadas para el AFC e indicadores bondad de ajuste

Factor	Reactivo	Carga factorial	S.E.	Valor de P
F1	EM2	0.837	0.019	0.000
	EM1	0.809	0.023	0.000
	EM3	0.832	0.021	0.000
	OC2	0.867	0.016	0.000
	EM4	0.819	0.017	0.000
	OC1	0.840	0.019	0.000
	EM5	0.774	0.023	0.000
	OC4	0.742	0.026	0.000
	OC3	0.716	0.026	0.000
	IP3	0.737	0.028	0.000
	EM6	0.663	0.03	0.000
	IP4	0.706	0.033	0.000
F2	EE4	0.830	0.028	0.000
	EE2	0.745	0.033	0.000
	EE3	0.823	0.024	0.000
	EE1	0.716	0.033	0.000
F3	IL1	0.701	0.029	0.000
	IL2	0.758	0.033	0.000
	IL3	0.636	0.042	0.000
	IL4	0.504	0.042	0.000
	IP1	0.491	0.043	0.000

Fuente: Elaboración propia

Tabla 5. AFC de segundo orden

Factor	Variable latente	Carga factorial	S.E.		Valor de P
Online	F1	0.579	0.040		0.000
	F2	0.572	0.047		0.000
	F3	0.515	0.047		0.000
	Índices de bondad y ajuste del modelo				
	$\chi 2$=770.407 gl=186 CFI= 0.892 TLI= 0.878 RMSEA=0.073 SRMR= 0.061				
	BIC Ajustado =5620.109				

Fuente: Elaboración propia

The structural model shows a regular fit, with CFI = 0.89, TLI = 0.88, which are considered acceptable when they are greater than 0.9, RMSEA = 0.073, which is considered acceptable, and SRMR= 0.061, which are desirable the closer they are to zero and the BIC index, where small values are acceptable (Bentler, 1990; Bollen, 1989; Chau, 1997).

With the purpose of improving the model, the strategy of testing with the elimination of the reagents that present low factorial load, in this case the IP1 and IL4 reagents, was followed to find an optimal solution to the proposed model. Thus, an instrument with 19 reagents was obtained. The results are presented in table 5.

Tabla 6. Cargas estandarizadas para el AFC e indicadores bondad de ajuste final

Factor	Reactivo	Carga factorial	S.E.	Valor de P
F1	EM2	0.838	0.019	0.000
	EM1	0.811	0.023	0.000
	EM3	0.833	0.021	0.000
	OC2	0.867	0.016	0.000
	EM4	0.819	0.017	0.000
	OC1	0.839	0.019	0.000
	EM5	0.774	0.023	0.000
	OC4	0.742	0.026	0.000
	OC3	0.714	0.026	0.000

	IP3	0.737	0.028	0.000
	EM6	0.663	0.030	0.000
	IP4	0.705	0.033	0.000
F2	EE4	0.830	0.027	0.000
	EE2	0.745	0.033	0.000
	EE3	0.824	0.024	0.000
	EE1	0.715	0.033	0.000
F3	IL1	0.633	0.031	0.000
	IL2	0.843	0.028	0.000
	IL3	0.672	0.037	0.000

Fuente: Elaboración propia

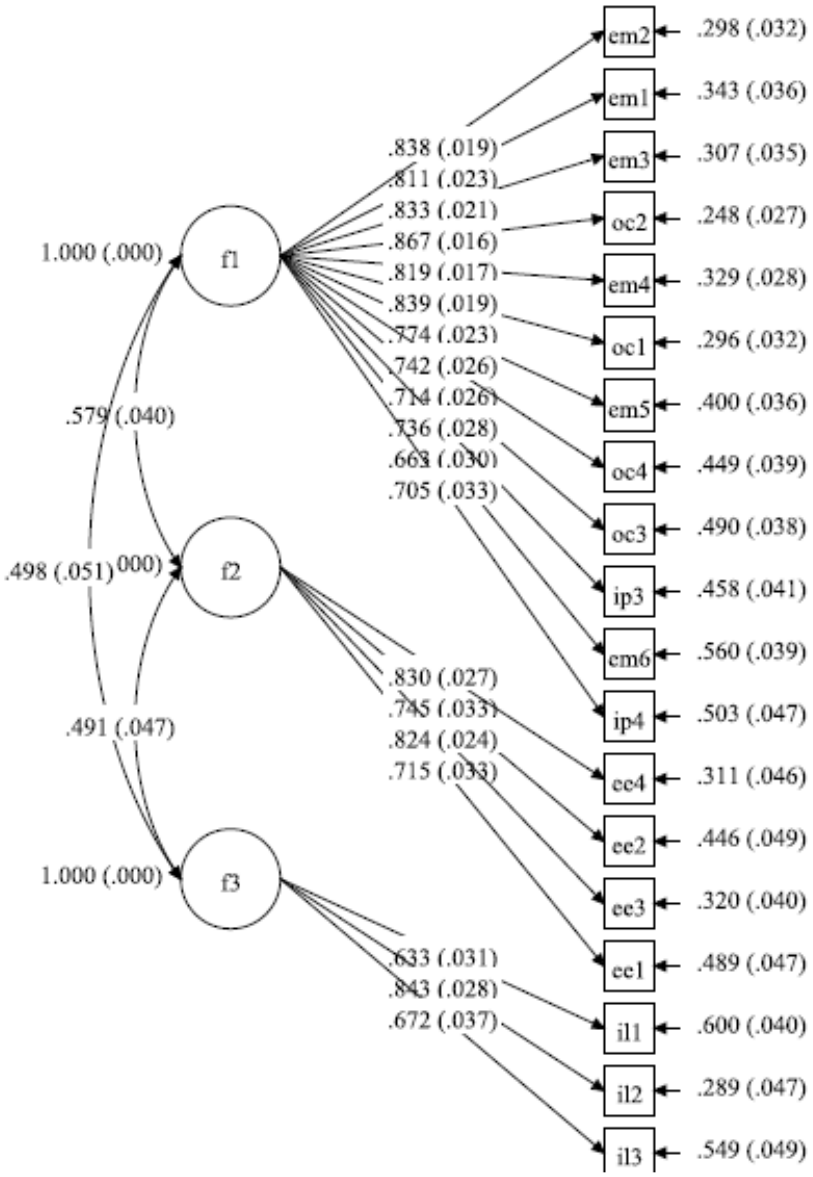
Tabla 7. AFC de segundo orden

Factor	Variable latente	Carga factorial	S.E.		Valor de P
Online	F1	0.579	0.040		0.000
	F2	0.498	0.051		0.000
	F3	0.491	0.047		0.000
	Índices de bondad y ajuste del modelo				

Fuente: Elaboración propia

In the new results of the CFA, it is observed that there is a more adequate fit compared to the first model and all the goodness indices yielded more acceptable values. Thus, based on these criteria, the model of this version is presented in Figure 3.

Figura 3. Modelo de Ecuaciones Estructurales.



Fuente: Elaboración propia

Discussion

Covid-19 caused the confinement of the population around the world, including those involved in higher education. Hence the need to implement courses in an emergent way. In schools with face-to-face modality, there was no preparation to face the situation, and since the pandemic does not yet have an end date, it is considered convenient to seek mechanisms for course evaluation from the student's perspective through a relevant model. This motivated

the development of this research at TecNM Celaya. The results coincide with those obtained by Cidral et al. (2018) in which the quality of collaboration, information, system, attitude of the instructor, diversity in the evaluation and interaction with students are the main factors that influence the evaluation of students in online courses. Similarly, the results found here are analogous to those of Flores and López (2019): the pedagogical, technological, interface design, evaluation, management and orientation areas should be considered for the evaluation of courses. Palmer and Holt (2009) found that students are satisfied with online learning as long as there is good organization in the course, well-defined activities and assessments, and timely feedback from the teacher; The same thing happened in this work.

However, differences were found with what was presented by Garris and Fleck (2020), who conclude that students perceive a lower quality of learning, unpleasant courses, less interesting and feel little involved in the process.

The research had as a limitation that there were not many antecedents of similar works. The strength of the research focuses on the excellent response of the students to participate and answer the instrument and the support of teachers, who participated in its application. The main area of opportunity is to enrich, strengthen and update the instrument considering the new research that is being developed in this regard.

An important difference in this research lies in the AFE and the AFC that were developed. Both give it a robust statistical support when generating the model of structural equations, unlike other investigations, such as that of Palmer and Holt (2009), whose results are based on statistical measures of mean, standard deviation and analysis of variance. . And that of Dziuban et al. (2012), who undertook a correlational analysis for the three factors included in their instrument.

Conclusions

This work shows the validation of a model that measures the perception of students towards the online courses that were established at the TecNM in Celaya in an emerging way due to the pandemic caused by covid-19. A quantitative method was used. The starting point was a general theoretical framework with five dimensions in the form of constructs; however, after applying an EFA, two variables that had a very low factorial load were removed, and the instrument was made up of 21 items. Subsequently, and in order to confirm the dimensions obtained in the AFE, a CFA was performed, which is of great help to retain or

discard the contribution to the formation of each latent variable. This analysis made it possible to reduce two indicators, whose factorial load did not contribute significantly to the construct. Fit indices $\chi 2$, gl, RMSEA, SRMR, CFI, TLI and BIC adjusted indicate that the constructs have been correctly identified and allows to ensure that a valid and reliable instrument has been achieved to measure the perception of students about online courses.

The final instrument was distributed in three dimensions: the first, which we call Organization of the course and student-teacher interaction, with 12 items; the second, "Student-student interaction", with four items, and the third "Individual interaction with the platform", with five items. The complete instrument is presented in Annex 1.

On the other hand, it is clear that the "Organization of the course and student-teacher interaction" presents independence with the factors "Student-student interaction" and "Individual interaction with the platform", and that students perceive the attention, availability, organization, instructions and feedback from teachers as the main factors to feel satisfaction with online courses.

With the validation of the instrument, it can be ensured that in general it is perceived that the students did not have great problems in adapting to the online courses, but they miss the interaction with professors and classmates. Also, that the way in which the professor designs and develops the course is essential for the achievement of her academic success and they highly value the professor's feedback. They also consider that teamwork, communication and information exchange were strengthened. The model and instrument proposed in this research offer a vision that can help teachers and administrators to take actions and decisions that improve the student experience in online courses. With the answers obtained from the students, it is inferred that the use of educational platforms has an important impact on the teaching strategy and that it is perceived as a tool that facilitates learning as long as it is designed with attractive, collaborative and interactive scenarios. and clear evaluation and feedback modes Finally, it is to consider that we are not on a "fad", but a reality caused by the covid-19 pandemic in which there is no certainty of when it will come to an end, which poses important challenges for all educational systems and that there is the possibility of rethinking the purpose of education, which undoubtedly includes the transition from face-to-face to virtual.

Contributions to future lines of research

It is recommended for future research and in order to improve the model, to replicate the instrument with other populations of students in other institutions that offer higher education and that have adapted their courses to this modality.

In the same way, it is very convenient to strengthen the instrument with the results of similar investigations that are being developed throughout the planet. It is also important to consider the evaluation of the transformations to the curriculum, because in this new context there are learnings and skills that are more relevant, such as health, self-learning, solidarity and resilience, among others. Finally, considering the hybrid or mixed modality that is being developed or planned in several higher education institutions, it will be convenient to evaluate this strategy with the instrument presented and make the pertinent adjustments.

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Rol de Contribución	Autor (es)
Conceptualización	Salustia Teresa Cano Ibarra (principal), María Teresa de la Garza Carranza (apoyo)
Metodología	Salustia Teresa Cano Ibarra (principal), María Teresa de la Garza Carranza (apoyo)
Software	José Porfirio González Farías (principal), Patricia Galván Morales (apoyo)
Validación	Salustia Teresa Cano Ibarra (principal), María Teresa de la Garza Carranza (apoyo)
Análisis Formal	Salustia Teresa Cano Ibarra (principal), Patricia Galván Morales (apoyo)
Investigación	Salustia Teresa Cano Ibarra (principal), María Teresa de la Garza Carranza (apoyo) José Porfirio González Farías (apoyo), Patricia Galván Morales (apoyo)
Recursos	María Teresa de la Garza Carranza (principal), José Porfirio González Farías (apoyo)
Curación de datos	Salustia Teresa Cano Ibarra (principal), José Porfirio González Farías (apoyo), Patricia Galván Morales (apoyo)
Escritura - Preparación del borrador original	Salustia Teresa Cano Ibarra (principal), María Teresa de la Garza Carranza (apoyo)
Escritura - Revisión y edición	Salustia Teresa Cano Ibarra (principal), María Teresa de la Garza Carranza (apoyo)
Visualización	Salustia Teresa Cano Ibarra
Supervisión	Salustia Teresa Cano Ibarra
Administración de Proyectos	Salustia Teresa Cano Ibarra
Adquisición de fondos	Salustia Teresa Cano Ibarra (principal), José Porfirio González Farías (apoyo)

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Anexo 1

Figura 4. Instrumento final

Debido a la pandemia por la covid-19 las clases presenciales se tuvieron que mudar hacia una modalidad en línea y así poder terminar el semestre en curso. Tomando en cuenta lo anterior, nos gustaría evaluar tu percepción sobre el desempeño de los cursos en general. Te pedimos que no tomes en cuenta de manera puntual cada uno de los cursos, sino más bien tu percepción del conjunto de los cursos.

Información general

Sexo: Carrera: Semestre:

Recursos informáticos a mi disponibilidad

1) Internet	*2)* Computadora de escritorio	*3)* Computadora portátil
4) Tableta	*5)* Teléfono celular	*6)* Ningún equipo de cómputo

A continuación, evalúa de acuerdo a la escala siguiente tu percepción sobre las diversas actividades que comprenden un curso en línea.

Escala de percepción

1 = Completamente en desacuerdo 2 = En desacuerdo 3 = Medianamente en desacuerdo 4 = Ni de acuerdo, ni en desacuerdo 5 = Medianamente de acuerdo 6 = De acuerdo 7 = Completamente de acuerdo

Dimensión 1: Organización del curso e interacción estudiante maestro

1) Los mae stros estaban disponibles cuando fue necesario
2) Existió atención oportuna del profesor cuando lo necesité
3) La retroalimentación de los profesores fue oportuna
4) El material de apoyo que envió el profesor fue pertinente
5) Los profesores utilizaron diversidad de actividades
6) El profesor tuvo un trato cordial y respetuoso
7) Los objetivos de los cursos fueron claros.
8) Las instrucciones del curso fueron claras
9) El tiempo establecido para realizar las actividades del curso fue suficiente
10) La evaluación de las actividades del curso fue justa y oportuna.
11) La interacción con el profesor a través de la plataforma fue de animación y motivación.
12) Los recursos adicionales para complementar el curso fueron oportunos y convenientes (Youtube, Scholar Google, correo electrónico, etc.)

Dimensión 2: Interacción estudiante-estudiante

1) Me fue posible contactar a mis compañeros cuando lo necesité
2) Hubo una sensación de comunidad entre los estudiantes durante el curso
3) Se facilitó el aprendizaje entre grupos de compañeros a través de interacción remota (Whatsapp, chats, etc.)
4) Se facilitó la comunicación e intercambio de información entre los compañeros

Dimensión 3: Interacción individual con la plataforma

1) Me concentro más fácilmente en mis cursos en línea
2) Mi experiencia en línea facilita acceder a material adicional por mi cuenta
3) Manejo mi propio aprendizaje en un curso en línea

Fuente: elaboración propia