Quantitative methods students' perception during a pandemic: e-learning support and course satisfaction

Percepción de los estudiantes de métodos cuantitativos durante pandemia: apoyo al aprendizaje en línea y satisfacción del curso

Diana L. Becerra-Peña
University of Guadalajara, Zapopan, Mexico
diana.bp@academicos.udg.mx
ORCID: 0000-0002-2796-3777

Alejandra Rosales-Soto
University of Guadalajara, Zapopan, Mexico
a.rosales@cucea.udg.mx
ORCID: 0000-0002-7630-9050

doi: https://doi.org/10.36825/RITI.10.22.006

Recibido: Junio 08, 2022
Aceptado: Septiembre 01, 2022

Abstract: The pandemic caused by COVID-19 removed the resistance to the digitalization of Higher Education (HE), which allowed the remaking of universities from innovation, flexibility, and hybrid and inclusive educational models. This research aimed to study the perception of e-learning support and students' satisfaction with Quantitative Methods subjects. For this purpose, we applied an online survey with 315 participants, through the second semester of 2021, from the University Center for Economic and Administrative Sciences (CUCEA) at the University of Guadalajara. Using exploratory factor analysis, we studied the survey responses. Three categories of support were identified: teacher support, peer support, and technical support. The empirical evidence showed that the support received is significantly related to student satisfaction, especially from their professor during e-learning through a pandemic. Likewise, many students considered that higher participation should have been during their online classes. In contrast, others believed greater involvement of their classmates could have improved the class dynamics. The results found are helpful for planners and decision-makers in HE because the educational model cannot go back to how it was before the coronavirus pandemic.

Keywords: *E-Learning, Quantitative Methods Education, Student Perception.*

Resumen: La pandemia provocada por la COVID-19 eliminó las resistencias a la digitalización de la Educación Superior (ES), lo que permitió rehacer las universidades desde la innovación, la flexibilidad y los modelos educativos híbridos e inclusivos. Esta investigación tuvo como objetivo estudiar la percepción del apoyo al aprendizaje en línea y la satisfacción de los estudiantes de las asignaturas con Métodos Cuantitativos. Para ello, aplicamos una encuesta en línea con 315 participantes, durante el segundo semestre de 2021, del Centro Universitario de Ciencias Económico Administrativas (CUCEA) de la Universidad de Guadalajara. Mediante un análisis factorial exploratorio, se estudiaron las respuestas de la encuesta. Se identificaron tres categorías de apoyo: apoyo docente, apoyo de pares y apoyo técnico. La evidencia empírica mostró que el apoyo recibido está

significativamente relacionado con la satisfacción de los estudiantes, especialmente de su Profesor durante el aprendizaje en línea en el transcurso de la pandemia. Asimismo, una buena parte de los estudiantes consideró que debería haber tenido una mayor participación durante sus clases online. Por el contrario, otros creyeron que una mayor participación de sus compañeros podría haber mejorado la dinámica de la clase. Los resultados encontrados son útiles para los responsables y los tomadores de decisiones en la ES, ya que el modelo educativo no puede volver a ser como antes de la pandemia de coronavirus.

Palabras clave: *Aprendizaje en Línea, Enseñanza de Métodos Cuantitativos, Percepción de los Estudiantes.*

1. Introduction

The COVID-19 pandemic forced drastic measures to stop contagions. Higher Education Institutions (HEI) response to the challenges imposed by the pandemic showed that the right path is innovation, flexibility, and hybrid and inclusive educational models. Moreover, due to the health crisis, the digitalization of higher education institutions has been accelerated by five to ten years [1]. The pandemic has removed the potential resistance to the digitalization of higher education, allowing the remaking of universities [2].

In face-to-face learning, priority is given to the interaction between people [3], and the Professor is the transmitter of knowledge [4]. The main disadvantage of face-to-face courses is the synchrony rigidity since both Professor and students are required to coincide in time and space, which leads to less autonomy on the part of the student.

Any non-face-to-face learning supported by Information and Communication Technologies (ICT) is considered online learning [5]. In this modality, the teacher is the specialist who designs, guides, and supervises the learning process [4] and requires a great deal of self-discipline on the part of the students [6]. Some disadvantages are ambiguity in teacher-student interaction, student self-discipline, high dropout rates, the possibility of student impersonation, the quality of computer equipment and Internet connections.

The digitalization of education systems introduced a new teaching-learning system called e-learning [7]. The face-to-face teaching experience cannot be fully replicated online; this implies that the environment built inside the classroom in conjunction with the non-verbal communication between teacher and students face-to-face is challenging to achieve at a distance [5].

In STEM disciplines, an ideal classroom is where students actively engage, making interdisciplinary connections, sharing ideas, and applying problem-solving strategies [7]. Over recent years, the concept of hybrid learning has become popular among STEM Professors [8].

For this reason, this paper aimed to study the perception of online learning support and satisfaction of students of Quantitative Methods subjects at the university level. For this purpose, an online survey is applied with the participation of 315 students. Their answers are studied through exploratory factor analysis.

This research was framed in an unplanned transition from face-to-face to e-learning, starting in March 2020 at the University of Guadalajara (Mexico) due to a pandemic. The results found will be helpful for planners and decision-makers in HEI on some good practices they can implement to make distance education bearable in a context of uncertainty.

2. Preliminary actions and contingency plan in Guadalajara, Mexico. Health emergency actions in Jalisco, Mexico

2.1. Health security measures by Mexico and Jalisco

The world has faced an unprecedented crisis ever since the SARS-CoV-2 virus emerged on December 19. Higher education institutions, along with government, business, and civil organizations, have assumed an essential role in managing the pandemic by implementing strategies to safeguard the health of the members of their community.

On March 17, 2020, face-to-face teaching was suspended in Jalisco, Mexico. By April 20, 2020, the government announced a mandatory and preventive social isolation period, which implied the suspension of economic activities, leaving only essential activities. However, despite the situation's urgency, the University of Guadalajara collaborated in economic reactivation with the state government, municipal authorities, business organizations, and civil society actors.

In Jalisco, health security measures have been reinforced, with the implementation of the COVID-19 Active Detection System, coordinated by the University of Guadalajara, the Civil Hospital of Guadalajara (HCG), and the Jalisco's Government, for the application of RT-PCR tests to the population at potential risk of having contracted the coronavirus.

2.2. Health crisis first actions by University of Guadalajara

The University of Guadalajara has a presence across the 12 regions that comprise the State of Jalisco, Mexico. It has six specialized campuses with 86,493 students and ten regional university centers with 50,177 students in 2020-2021, representing 43.96% of the total enrollment. In response to the COVID-19 health emergency generated by the SARS- CoV-2 coronavirus, Universities became the first actors to respond to the health crisis by placing their infrastructure, equipment, and human resources at the service of the containment and management tasks of the pandemic [9].

Starting in March 2020, Universities suspended the face-to-face modality. They transitioned to a virtual model to provide academic programs with continuity and carry forward to fulfill their essential functions. Under the University of Guadalajara's tradition, mission, and principles, it deployed actions that allowed permanent management of the epidemiological emergency through various lines of action, as shown in Table 1. The measures derived from the health emergency were not only focused on the student's well-being but also business economics. Furthermore, in the first half of 2020, two emerging applications were to support University students on an academic stay abroad for their repatriation.

Table 1. Health emergency actions 2020. University of Guadalajara.

Action	Description
Health Situation Room Installation	Communicate the characteristics of the COVID-19 disease promptly to the university community and the population in general and the most appropriate methods for its prevention and care.
COVID-19 Active Detection System Enablement.	Application of real-time PCR diagnostic tests and advisory services to the citizens through a call center.
Hospital Reconversion Plan for the Municipal Public Hospitals of Guadalajara.	Adaptation and equipping of hospital spaces to meet the demand for clinical care for COVID-19.
Voluntary Isolation Center Adaptation.	Provide accommodation for those with positive asymptomatic results or mild symptoms to avoid hospital overcrowding.
Production, transfer, and dissemination of knowledge.	Educational content, webinars, and advertising spots broadcasted on the Internet, television, and radio to support the transition to virtual classes. Promotion of Learning Management System (LMS). The University of Guadalajara and the Massachusetts Institute of Technology (MIT) created a project to detect COVID-19 infection by measuring cough.
University social responsibility actions.	Assist students by lending computers and tablets equipment, oximeters and supplying provisions for free meals. SME consultancy for reactivating businesses and adapting them to the post-pandemic situation.

Geographical representation of contagion	Study the impact of agglomerations linked to daily activities through simulations in a REPLICA computer model.
Vaccination Plan design.	Develop a statewide vaccination campaign network supported by student volunteers for registration and health care personnel for vaccination.

Source: Own elaboration.

2.3. University Center for Economic and Administrative Sciences (CUCEA) Contingency Plan

CUCEA is the campus with the highest population of sixteen University Centers. The 2020 student population comprised 21,746 students, 1,479 more than in 2019, representing an increase of 7.3% of the University Center's enrollment. CUCEA campus has striven yearly to provide better coverage and positively impact the enrollment variation. Of the total enrollment, 95% are undergraduate students (20,798), and 5% are postgraduate students (948) [10].

CUCEA campus is distinguished too by its younger student population, based on the statistical criteria of the United Nations, which defines this population as those between 15 and 24 years old. In the University Center, 89% of the total student population (19,372) fulfills these criteria; therefore, of the 21,746 undergraduate students at the University Center, 89% are between 15 and 24 years old.

The academic, administrative, and other employees have made extraordinary efforts. Work shifts were formed to provide essential services to guarantee health and reduce the risk of contagion in the university community. The administrative field has been immersed in the processes and procedures of the groups most vulnerable to the disease. The academic field enables non-face-to-face classes to be taught online using different LMS platforms such as Google Classroom and Moodle and videoconferencing applications such as Google Meet, Zoom, and Cisco Webex.

In response to the sanitary emergency, the policies adopted by the General University Council, in coordination with the Rector's council, was to implement the Emergency Plan for the Academic Development of the University Center in the face of the COVID-19 contingency, which was called CUCEA COVID-19 PLAN (CCP) [11]. The CCP plan aims to prioritize the health and welfare of the CUCEA community during the health emergency and strategically integrate various actions, as shown in Table 2, that fulfill the substantive functions of the University Center, mainly to save the semester and prevent anyone from being left behind.

Table 2. CUCEA Covid-19 Plan.

Plan actions	Objective
Campaign for Donation of Computer Equipment, mobile devices, and provision of temporary internet access.	Contribute to the academic progress of economically vulnerable students.
CUCEA online website	Enables the management of the academic life of the University Center, integrating webinars, courses, online education, and sites of interest, among others.
Mentoring virtual program	Help students solve their doubts about classes and reinforce students' performance in vulnerable conditions.
Online Librarian	Strengthen the library services of counseling and support to students searching for information.

Student Mobility Program	Provide support to self-study of foreign languages virtually through conversation clubs with topics related to their careers. Promote virtual academic research stays in universities abroad and support the repatriation of university students on an educational stay abroad.

Source: Own elaboration.

The Emergency Plan for the Academic Development of CUCEA during the COVID-19 contingency sought to prioritize the health and well-being of the University's students, faculty, and staff. The Plan's actions promote the autonomous use of online learning platforms and other digital technologies. According to Lubis & Dasopang [12], this is an opportunity to increase the technological capabilities of teachers and students. Such support has been mainly focused on teaching and learning and the internationalization of education. Hence, the importance of knowing the perception of online learning support and satisfaction of students in this community.

3. Materials and methods

For this research, a survey was prepared to know the students' perceptions about their experience in e-learning of Statistics I and Quantitative Methods I courses. Both courses belong to the Quantitative Methods Department. They were lectured through the second semester of 2021 at CUCEA of the University of Guadalajara in Mexico.

The survey, piloted and validated, was opened via Google Forms for two weeks between November 11 and 26, 2021. The Professor distributed it through Google Classroom in nine groups: six groups from Statistics I and three groups from Quantitative Methods I. The students were requested to participate, stating the survey was administered for academic purposes to analyze their perception of the online learning of their Quantitative Methods subjects and emphasize that the responses would be anonymous so that they would be as objective as possible.

The survey contained 42 questions (see section 6. Appendix), 25 items with a 7-point Likert scale - the satisfaction scale with item statements ranged from 1 "strongly disagree" to 7 "strongly agree" - 14 multiple-choice questions and three open-ended questions. The Likert-scale questions have been adapted from the work of Lee et al. [13], which was applied during the 2010 spring semester in an early online introductory public health course conducted on the Blackboard 9 platform without any face-to-face component. In contrast to the research of Lee et al. [13], the classes analyzed here did have a face-to-face component (as will be explained in section 3.1). Additionally, the student's context is different since these are subjects with high numerical content; also, they experienced a series of sudden changes during a pandemic. It should also be noted that the 25 items of the Likert-scale were translated into Spanish for their application. The 14 multiple choice questions were integrated into the instrument to know the characteristics of the students, and finally, the open-ended questions were included to inquire about their opinions.

For data collection in this research, each item had been marked as obligatory to complete and submit the survey using Google Forms. However, the response patterns were reviewed to observe if the students surveyed understood the instructions and discarded those answers with the same response in each question. A total of 315 validated answers came from students taking courses in the Quantitative Methods Department. From the total number of students, 95 (30.2%) were enrolled in the Quantitative Methods I course and 220 (69.8%) in the Statistics I course. Among the 315 participants, 213 (67.6%) were female, and 102 (32.4%) were male. In addition, regarding the undergraduate semester, the students were enrolled at the time of the survey, 102 (32.4%) were second semester, 171 (54.3%) third semester, 28 (8.9%) fourth semester, 10 (3.2%) fifth semester, and 4 (1.2%) sixth semester.

Out of the total number of students (n=315), 95 (30.2%) belonged to the Gastronomic Business Management degree, 53 (16.8%) to International Business, 44 (13.9%) to Financial Management and Systems, 34 (10.8%) to Administration, 35 (11. 1%) to Marketing, 19 (6%) to Public Accounting, 9 (2.8%) to Human Resources, 6 (1.9%) to Public Relations and Communication, 6 (1.9%) to Tourism, 5 (1.6%) to Government Administration and Public Policy, 5 (1.6%) to Economics and 4 (1.2%) to Information Technology. The students surveyed have an average age of 19.98. Of the 315 students surveyed, only 64 (20.3%) reported taking online courses before the pandemic. When the semester began, 184 (58.4%) had a paid job, while only 162 (51.4%) reported having a paid job at the

end of the semester.

Concerning ICTs, almost all students (98.7%) have Internet connectivity at home. Of the devices used to access their online class, the laptop stands out with 204 users (64.8%), followed by the smartphone with 61 users (19.4%), the desktop computer with 39 users (12.4%), and the electronic tablet with 11 users (3.5%). Of the total respondents, 93 (29.5%) stated sharing an electronic device to access their online class.

3.1. Educational setting and design

It is noteworthy that the Quantitative Methods I course is taught only to students of the Gastronomic Business Management degree, while the Statistics I course is taught to all CUCEA bachelor's degrees except for Gastronomic Business Management and Business Engineering. Despite the above, all students from the surveyed groups had the same class dynamics within the Google Classroom platform in charge of a female Professor. Each student was sent an invitation one week before the beginning of the semester to join their Google Classroom, where the Professor posted a welcome message and a brief description of their academic curricula.

The platform is organized as follows:

- Stream: The virtual classroom timeline shows the Professor's shared messages to her students, notices as material files are uploaded, and assigned class assignments and homework.
- Classwork: Contains the class book, the material used during the classes and other support resources (grouped by thematic unit), a section for homework, another one for class comprehension exercises, an area with videos of the class topics (hosted on YouTube), other space with the recordings of the videoconference made, a section for the solutions of the exercises, and the evaluations area.
- People: Here are the Professor's name next to her email icon, as well as the names of all classmates.

During the first session, the Professor explained the dynamics of the class, the format for submitting assignments and exercises. Also showed the calendars for the course evaluation, the topics each includes, and the ways to contact in case of doubts or comments (email for personal situations and Google Classroom for class issues). The semester lasted fifteen weeks, of which thirteen were online and two face-to-face (attendance was not mandatory). Class comprehension assignments, homework, and evaluations were handed in individually. Students created their support network, independent from Google Classroom, with WhatsApp groups being a communication channel not contemplated within the course design; Professor decided not to belong to it, thus allowing an exclusive space for students. Each lesson was conducted through a videoconference on Google Meet. The recording hosted on the Professor's YouTube channel was shared only with each group to protect the student's identity. In addition, the Professor's presentations were shared in PDF and video format and complementary material from other authors. The Professor answered all the messages from her students and gave them comments on their assignments. She also shared with them the official notices and regulations of the University and its campus, announcements of competitions, exchange programs, training, and financial support.

4. Results

According to the survey responses, the students' perceptions were studied through exploratory factor analysis with the help of SPSS. The 25 survey questions with a Likert scale (ordinal qualitative variables) were selected and accompanied by the following instruction: "Read the following statements about your Quantitative Methods course and answer based on your experience this semester".

A test of internal consistency of the items was performed by a Cronbach's alpha reliability analysis (0.788), the item-total correlation was evaluated, the squared correlation with the scale items, and the reliability value if the item was eliminated. Preliminary results suggest using six components, which explain 66.389% of the total variance. The anti-image correlation matrix is revised, and those items with the lowest values are eliminated: TC1 (0.663) and TC2 (0.532). In addition, according to the communalities table, those items with the lowest values in extraction are eliminated: TS7 (0.391) and PS3 (0.504).

The above procedure is repeated without the previously mentioned items. After adjustments, with 21 survey questions, results suggest using five components to explain 68.11% of the total variance. However, the rotated

components matrix shows that components four and five are two items each, which implies one of these components cannot be considered since at least three items are required to form a component. Item PS4 is eliminated.

The above indicates the use of four components; additionally, this is supported by the research of Lee et al. [13]. The factors are represented as follows:

- Teacher Support: Represents Professor's guidance in the teaching-learning process. It includes giving clear instructions, offering relevant and adequate material, answering doubts and messages from students, and providing feedback on activities and evaluations.
- Course Satisfaction: Refers to students' attitudes and feelings about their experience and outcomes in the course.
- Peer Support: Represents the actions of students towards their peers. It includes elements such as interaction, answering questions and messages, and study groups formation.
- Technical Support: Refers to Professor's help in resolving some difficulties using Google Classroom.

The eigenvalues greater than 1 show the four factors; this solution converged in five interactions and explained 64.67% of the total variance. The items present factor loadings greater than 0.50 within their factor, and communalities were greater than 0.40. The final composition, including twenty items, is correct (see Table 3), with a Cronbach's alpha of 0.864. Barlett's test of sphericity was significant (3403.811, df = 190, sig.< 0.001), while the Kaiser-Meyer-Olkin (KMO) sample size adequacy indicator was adequate (0.915).

Table 3. Survey on students' perception of their online learning experience.

Category	Cronbach's alpha	Code	Factor loading
Teacher Support	0.916	TS10	0.869
		TS8	0.853
		TS9	0.729
		TS3	0.726
		TS1	0.715
		TS5	0.714
		TS4	0.694
		TS6	0.693
		TS2	0.641
Course Satisfaction	0.832	CS3	0.794
		CS4	0.794
		CS5	0.783
		CS1	0.668
		CS2	0.623
Peer Support	0.726	PS2	0.885
		PS1	0.861
		PS5	0.563
Technical Support	0.628	TC5	0.788
		TC3	0.772
		TC4	0.613

Source: Own elaboration.

The descriptive statistics of the factors made up of the twenty Likert scale questions were obtained; the results are shown in Table 4. In general, it is observed that the students are satisfied with the support offered by their Quantitative Methods Professor. On the contrary, according to the evaluation, peer support was considered the lowest category in support (Mean = 5.63), given activities carried out during the semester did not involve mandatory teamwork, nor were group discussions formally carried out.

Table 4. Descriptive statistics for variables.

Category	Mean	Min.	Max.	SD	N
Teacher Support	6.82	6.68	6.92	0.08	315
Course Satisfaction	6.46	6.10	6.80	0.30	315
Peer Support	5.63	5.09	6.32	0.63	315
Technical Support	6.15	5.62	6.61	1.57	315

Source: Own elaboration

Table 5 shows the results of the bivariate correlation test. The correlation analysis shows that the student's perception of the teacher support received in their Quantitative Methods course has a positive and significant relationship with course satisfaction (r = 0.613). In general, all correlations were positive and significant; however, a lower relationship was observed between peer support and course satisfaction (r = 0.259).

Table 5. Correlation matrix.

	Teacher support	Course satisfaction	Peer support	Technical support
Teacher support	1	0.613**	0.270**	0.360**
Course satisfaction	0.613**	1	0.259**	0.334**
Peer support	0.270**	0.259**	1	0.277**
Technical support	0.360**	0.334**	0.277**	1

** Correlation is significant at 0.01 level (two-tailed).

Source: Own elaboration

One of the open-ended questions asked which courses they considered ideal for e-learning, and students were asked to mention at least three subjects within their study plans. According to their opinion, the following subjects stand out: Statistics (n = 79), Law and everything related to the legal framework (n = 77), Foreign Languages (n = 70), Administration (n = 65), Mathematics (n = 49), Quantitative Methods (n = 45), Economics (n = 44), Information Technology and everything related to programming (n = 37) and Accounting (n = 32).

In general, the students stated that those subjects with a higher theoretical content, whose subject matter is straightforward to understand, were ideal for e-learning. In addition, this modality allows the use of different technological tools that facilitate the teaching-learning process and greater availability of material that can be shared more quickly. Also, according to their experience and degree of satisfaction with the Quantitative Methods course taken that semester, most students suggest the implementation of e-learning in classes with high numerical content.

In addition to the above, when students were asked how they could improve their Quantitative Methods class, most of the answers stated that the course did not need changes since it was to their liking. In addition, quite a few students consider that despite having had an enjoyable experience and being satisfied, they would have liked to have more face-to-face sessions, as can be read in the following statements obtained from the survey:

> "This course is too complete, and the teacher straightforwardly gives the class so that we can all understand the topics seen in class, but I would have liked to have this subject face-to-face to learn even so more".
> "In my opinion, this course was conducted in the right way, I got my expected learning, and the only thing that could have contributed to making me enjoy it more has it in a face-to-face manner".

Secondly, students stated that a greater number of evaluations should be considered. Within the didactic planning of that semester, the Statistics I course has four assessments (exams) programmed for having thematic content composed of seven units. In contrast, the Quantitative Methods I class has three programmed since it consists of four thematic units.

Likewise, many students consider that higher participation should have been during their online classes. Some believe that if they had participated more, they would have taken more advantage of the course concerning resolving their doubts. Others mentioned that the same students always attended, believing that the class dynamics could have been improved with greater participation of their classmates. At the same time, others referred to this situation by suggesting more interaction between classmates and the teacher.

According to the factor analysis results, the statements made in the sense of low/no participation in class are related to a low association between the Peer Support and Course Satisfaction categories (Table 5). This is consistent with the results found in McCullough and Aimard [14], where the involvement intensity of the participants and presence were considered as crucial factors of e-learning success. Both the preference for the face-to-face modality and interaction are consistent with Lee et al. findings [13], which show that these aspects are related to the student's perception of the support received in the course. This leads to the assumption that more interaction between teachers and students - in person or online - improves students' perception and, consequently, their satisfaction.

In this same open question - instead of mentioning improvement aspects -, the students expressed what they liked most about their class, among what stands out was found the availability of material and the recordings of the videoconference. In this regard, student #35 said: "[...] in the three semesters that I have been in my career, I feel that this course is the one that best adapted to online learning because it gives us only the necessary resources, with the necessary information, that is, it does not confuse you. Also, you can consult the material in the way you prefer, either audiovisual or just the document".

In the same context, student #182 said: "I was satisfied with how the course was taught because, thanks to the Professor's recordings, if I missed something I had seen in class, I could take it up again in the recording". Finally, most of the students highlight as notable aspects of their class some issues that have to do exclusively with the characteristics/qualities of the Professor in charge of the course, such as constant and timely communication, dynamism, motivation, patience, and organization. In this context, student #86 said: "Everything was excellent. I liked the way the teacher gave the class. She gave us a lot of support material for the class and was very understanding; she always cared about us and gave us positive feedback. It was one of my favorite subjects. Simply that the course was excellent virtually, I got a lot of support".

Along the same lines, student #31 said: "If it had been face-to-face from the beginning, however, the teacher knew how to help us learn, even if it was online. She is one of the few teachers with whom I have felt comfortable asking questions and making mistakes since she always gives you her support and has a lot of patience". While student #288 stated: "I have not had a class as dynamic as this one", and student #13 highlighted: "Learning behind a screen without generating stress, knowing that you can learn online when you have the right teacher".

The above statements confirm that constant communication from the Professor through messages in the virtual classroom or via email is vital for efficient e-learning in classes with a numerical background [4]. It is also related to the study findings by Sedaghatjou *et al.* [7], who identify the affective domain of teaching as the missing dimension in the e-learning framework. Additionally, these learners' responses corroborate the results obtained in the factor analysis, which confirms a positive and significant relationship between Teacher Support and Course Satisfaction dimensions, with the highest correlation coefficient. Because the contributions of these technologies to the teaching-learning process are not only relevant from the cognitive and procedural point of view but also when used from the attitudinal point of view, they contribute to the formation and promotion of human values. and promotion of human values [15].

5. Conclusions

The sudden change to migrate from face-to-face teaching in a context of high uncertainty appears to be an early success in general - regardless of the quality of the internet connection - due to the rapid adaptation in the integration and use of technologies. In this sense, both the literature review and the empirical evidence show digitalization process of Higher Education consists of online learning - which involves the use of an Internet connection in the teaching-learning process - and factors in addition to technology. All this contributes to the construction of an e-learning experience facing the COVID-19 pandemic situation, which will continue to evolve constantly as new and different technologies - in addition to an Internet connection - are integrated to improve the teaching-learning process.

Under this scenario, teaching courses with high numerical content - as is the case of Quantitative Methods courses - requires constant social interaction, manifested through teacher support and peer support, as could be seen in this research when analyzing the perception and satisfaction of students in pandemic time. This scenario implies special attention to Professor and students' interaction forms, given the positive association they maintain with the level of student satisfaction. As expressed by many of the students surveyed - despite the difficulties that a STEM discipline may represent for different learning styles - if constant and timely communication, dynamism,

motivation, patience, and organization on the part of their professor, the teaching-learning experience is satisfactory. Likewise, to mitigate low peer-to-peer interaction and limited or no face-to-face interaction-evidence has shown that these interactions are of utmost importance in learning activities related to numerical backgrounds-, the incorporation of collaborative learning is suggested either using online forums [4] or during videoconferences through breakout rooms or chat function [7].

Finally, more research is needed on the experiences of both students and teachers in numeracy-intensive subjects, especially in the context of pandemics. Information detailing the different backgrounds can contribute to identifying good practices and thus improve the teaching-learning experience and curriculum design in subsequent courses.

6. References

[1] Komljenovic, J. (2020). The Future of Value in Digitalised Higher Education: Why Data Privacy Should Not Be Our Biggest Concern. *Higher Education*, *83*, 119-135. https://doi.org/10.1007/s10734-020-00639-7

[2] Williamson, B., Sian, B., Suellen, S. (2020). The Datafication of Teaching in Higher Education: Critical Issues and Perspectives. *Teaching in Higher Education, 25* (4), 351–65. https://doi.org/10.1080/13562517.2020.1748811

[3] Graham, C. R. (2006). Blended Learning Systems: Definition, Current Trends, and Future Directions. En C. J. Bonk, C. R. Graham (Eds.) *The Handbook of Blended Learning: Global Perspectives, Local Designs* (pp. 3-21). Pfeiffer Publishing. http://curtbonk.com/graham_intro.pdf

[4] Juan, A., Huertas, A., Steegmann, C., Córcoles, C., Serrat, C. (2008). Mathematical E-Learning: State of the Art and Experiences at the Open University of Catalonia. *International Journal of Mathematical Education in Science and Technology* 39 (4), 455–71. https://doi.org/10.1080/00207390701867497

[5] Martínez, V. (2017). Educación Presencial versus Educación a Distancia. *La Cuestión Universitaria*, (9), 108–116. http://polired.upm.es/index.php/lacuestionuniversitaria/article/view/3582

[6] Collis, B., Bruijstens, H., der van Veen, J. K. (2003). Course Redesign for Blended Learning: Modern Optics for Technical Professionals. *International Journal of Continuing Engineering Education and Life-Long Learning* , *13* (1–2), 22–38. https://doi.org/10.1504/ijceell.2003.002151

[7] Sedaghatjou, M., Hughes, J., Liu, M., Ferrara, F., Howard, J., Mammana, M. F. (2021). Teaching STEM Online at the Tertiary Level during the COVID-19 Pandemic. *International Journal of Mathematical Education in Science and Technology*, 1-17. https://doi.org/10.1080/0020739X.2021.1954251

[8] Sedaghatjou, M., Kaur, H., Williams, K. A. (2020. Developing Interactive Demonstrations for the Online Mathematics Classroom. En J. P. Howard, J. F. Beyers (Eds.), *Teaching and Learning Mathematics Online* (pp. 337–356). Chapman and Hall/CRC. https://doi.org/10.1201/9781351245586-20

[9] University of Guadalajara. (2020). *Informe 2020. Rectoría General*. https://rectoria.udg.mx/informe2020

[10] University of Guadalajara. (2021). *2do. Informe de Actividades CUCEA*. https://informe-2020-2021.cucea.udg.mx/wp-content/uploads/2021/06/informe-cucea-2020-2021.pdf

[11] University of Guadalajara. (2020). Plan CUCEA Covid 19. https://contingencia-covid-19.cucea.udg.mx/plan-cucea-codiv-19/

[12] Lubis, A. H., Dasopang, M. D. (2021). Online Learning during the Covid-19 Pandemic: How Is It Implemented in Elementary Schools? *Premiere Educandum : Jurnal Pendidikan Dasar Dan Pembelajaran, 11* (1), 120-134. https://doi.org/10.25273/pe.v11i1.8618.

[13] Lee, S. J., Srinivasan, S., Trail, T., Lewis, D., Lopez, S. (2011). Examining the Relationship among Student Perception of Support, Course Satisfaction, and Learning Outcomes in Online Learning. *The Internet and Higher Education, 14* (3), 158–63. https://doi.org/10.1016/j.iheduc.2011.04.001

[14] Mc Cullough, C., Virginie, A. (2006). *E-Learning in Europe: How Do Trainers, Teachers and Learners Rate e-Learning? https://www.cedefop.europa.eu/files/etv/Upload/Exchange_views/Surveys/Report_survey_Teachers_and_Learners_and_e-learning_final.pdf*

[15] Díaz Rosabal, E. M., Díaz Vidal, J. M., Gorgoso Vázquez, A. E., Sánchez Martínez, Y., Riverón Rodríguez, G., Santiesteban Reyes, D. C. (2020). La dimensión didáctica de las tecnologías de la información y las comunicaciones. *Revista de Investigación en Tecnologías de la Información (RITI)*, *8* (15), 8-15. https://doi.org/10.36825/RITI.08.15.002

Appendix A. Survey on students' perceptions support and course satisfaction in online learning

Category	Code	Item
Teacher Support	TS1	The Professor clearly defined course goals/objectives.
	TS2	I knew what I would be expected to accomplish each week.
	TS3	The Professor gave clear instructions for assignments and exams.
	TS4	The course provided resources relevant to this subject.
	TS5	Feedback on assignments was helpful.
	TS6	I felt that I could ask the Professor any questions regarding the course materials.
	TS7	There were specific ways to communicate with the Professor.
	TS8	I found the Professor to be easily accessible.
	TS9	The Professor encouraged students to succeed in this course.
	TS10	The Professor answered student questions promptly.
Course Satisfaction	CS1	This course increased my interest in Quantitative Methods.
	CS2	I felt that I achieved the objectives of this course.
	CS3	I liked the format of the course (online).
	CS4	I felt comfortable in this course.
	CS5	I would recommend this course to others.
Peer Support	PS1	I had opportunities for group discussions.
	PS2	There were many opportunities to interact with my classmates.
	PS3	I hesitated to ask my peers for help.
	PS4	I felt respected by my peers.
	PS5	Students in this course were willing to help other students.
Technical Support	TC1	I had many technical problems in this course.
	TC2	Asking for technical assistance was difficult for me.
	TC3	The Professor responded to my technical problems promptly.
	TC4	I felt I could get technical support when needed.
	TC5	I knew where to ask for help when I had technical problems.
Course improvement	CI1	How could this course have contributed better to your learning?
	CI2	Which courses, in your opinion, are ideal for the online modality? Mention at least three.
	CI3	In one sentence, describe why these courses are ideal for the online modality.

Source: Own elaboration.