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Research article

Perceived instructor presence, interactive tools, student engagement, and satisfaction in hybrid education post-COVID-19 lockdown in Mexico

Ramón Ventura Roque-Hernández [a,b,*], Adán López-Mendoza [a,b,**], Rolando Salazar-Hernandez [a,b,***]

[a] Facultad de Comercio, Administración y Ciencias Sociales, Universidad Autónoma de Tamaulipas, Nuevo Laredo, Mexico
[b] Ayuntamiento Sur SN, Infonavit Fundadores, Nuevo Laredo, Tamaulipas, Mexico, Zip Code 88000

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ABSTRACT

Interactive communication platforms have been widely used to support online teaching. However, during the Coronavirus Diseases 2019 (COVID-19) pandemic they gained unprecedented relevance since they allowed educational processes to continue. This study investigated the relationship among interactive communication technology tools, perceived instructor presence, student satisfaction and engagement in hybrid courses post-COVID-19 lockdown. An electronic questionnaire was administered to 1086 students from a public university in Mexico that implemented a hybrid class model using Microsoft Teams after the lockdown. Jamovi and WarpPLS were used to perform confirmatory factor analysis and structural equation modeling. The findings revealed that interactive technological communication tools positively impact the instructor's perceived presence, student satisfaction and engagement. Similarly, commitment significantly positively impacted student satisfaction. The model demonstrated a good fit. The findings were consistent with studies before and during the lockdown. The instructor's perceived presence promotes student engagement and satisfaction, and Microsoft Teams effectively facilitates this presence. These findings suggest that interactive communication tools are and will be significant in educational contexts and modalities. This study provides useful insights for educators, course designers and educational administrators, emphasizing effective communication with students and implementing interactive technological communication tools to enhance hybrid learning in the post-pandemic era.

1. Introduction

Interactive communication tools have played a significant role in facilitating online teaching. However, during the Coronavirus

* Corresponding author. Facultad de Comercio, Administración y Ciencias Sociales, Universidad Autónoma de Tamaulipas, Nuevo Laredo, Mexico.
** Corresponding author. Facultad de Comercio, Administración y Ciencias Sociales, Universidad Autónoma de Tamaulipas, Nuevo Laredo, Mexico.
*** Corresponding author. Facultad de Comercio, Administración y Ciencias Sociales, Universidad Autónoma de Tamaulipas, Nuevo Laredo, Mexico.
E-mail addresses: rvhernandez@uat.edu.mx (R.V. Roque-Hernández), alopez@uat.edu.mx (A. López-Mendoza), rsalazar@docentes.uat.edu.mx (R. Salazar-Hernandez).

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Diseases 2019 (COVID-19) pandemic, these technologies became essential for allowing teaching and learning processes to continue through virtual platforms. Furthermore, interactive communication tools enable real-time collaboration and communication between students and teachers, enriching the learning experience and reducing the isolation of this educational modality [1].

Park & Kim [2] studied the perceived instructor presence in the context of online learning before the pandemic. In that research, 67 undergraduate students were surveyed, and their responses were analyzed through structural equation modeling. The proposed model made it possible to demonstrate that Microsoft Teams, as an interactive communication tool, strengthens perceived instructor presence, which subsequently improves student engagement and satisfaction in online courses. On the other hand, it was found that student engagement also has a positive incidence on student satisfaction.

The same model was tested afterwards by Roque-Hernández et al. [3] with data collected during the emergency remote education scenario due to the COVID-19 pandemic. In that study, 1417 undergraduate students from five different academic programs participated. Microsoft Teams was also used as an interactive communication tool. The analyses were based on structural equation modeling. Their results were similar to those of Park & Kim [2] for each academic program.

Following both studies, the interactive communication tools and the perceived presence of the instructor in online courses have been important for teaching and learning processes before and during the pandemic, as they have positively impacted student satisfaction and engagement. Interactive technological communication tools, such as Microsoft Teams, have enhanced the instructor's presence by facilitating more efficient communication with students. Thus, a stronger instructor presence has been positively correlated with higher student satisfaction, given that students have felt more connected and supported throughout their learning journey. Additionally, the perceived presence of the instructor has been positively associated with increased student engagement, manifested through greater participation in activities and a deeper commitment to the learning process.

Despite the increasing research on the significance of instructor presence and interactive communication tools, it is crucial to further explore these constructs in post-COVID-19 hybrid learning environments. The switch to online and hybrid education prompted by the pandemic has quickened the adoption of these technologies, demanding an appraisal of their effectiveness in fostering learner engagement and satisfaction. While previous studies have provided valuable insights, there is a gap that requires research on instructor presence and student outcomes in the post-pandemic era.

Furthermore, the choice of communication platform can have a significant effect on the learning experience. Microsoft Teams, a widely used communication tool, has gained relevance in educational settings. However, its contribution to instructor presence and learner satisfaction in a hybrid learning context after the COVID-19 lockdown needs examination, as the current versions of this program have been updated with enhanced functionalities compared to those available before and during the pandemic. As educators delve into designing effective hybrid courses, understanding the role of tools such as Microsoft Teams is critical to optimizing the learning environments.

This study investigated the effects and relationships among interactive tools, the perceived instructor presence, student engagement and satisfaction with the hybrid learning modality adopted after the COVID-19 lockdown in Mexico. The post-pandemic results were compared with those previously reported by Park & Kim [2] before the pandemic and by Roque-Hernández [3] during the lockdown. The intention underlying this research is to provide useful insights to educators, leaders and administrators who are striving to improve the quality of hybrid learning experiences beyond the challenges posed by the pandemic. Thus, our research question was: Which relationships of the model tested by Park & Kim [2] and Roque-Hernandez et al. [3] are valid in the post-pandemic hybrid educational setting?

Fig. 1 shows the structural equation model (SEM) analyzed in this work. Following the same arguments from Park & Kim [2], the research hypotheses are.

H1. The tool's interactivity -TEAMS- positively and significantly impacts the perceived instructor presence -PIP-.

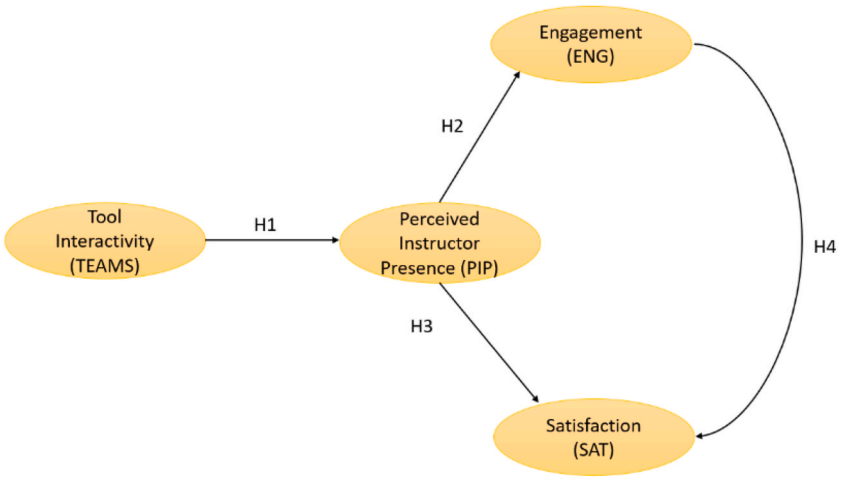

Fig. 1. Graphic representation of the model analyzed in this study and the hypotheses.

H2. Perceived instructor presence -PIP- positively and significantly impacts student engagement -ENG-.

H3. Perceived instructor presence -PIP- positively and significantly impacts student satisfaction -SAT-.

H4. Student Engagement -ENG-positively and significantly impacts student satisfaction -SAT-.

The remainder of this paper is structured as follows: the literature review is followed by a description of the applied methodology. Subsequently, the results, discussion, conclusions and future lines of work are presented.

2. Literature review

2.1. Student satisfaction

Student satisfaction is a complex and multidimensional concept influenced by several factors. Asosega et al. [4] defined student satisfaction as the overall evaluation of a student's contentment in the university environment, and it can be measured across various areas, including campus facilities and infrastructure, university social life, student support services, and academic quality. They also highlighted that sustained student satisfaction can result in a high retention rate, attract new students and contribute to the profitability of educational institutions. Therefore, universities should continuously monitor and improve service quality to ensure student satisfaction.

Alqahtani et al. [5] stated that student satisfaction is the assessment students make about the extent to which their expectations, objectives and desires are met. Similarly, Zhao et al. [6] explained that student satisfaction is related to academic outcomes and is a measure of success or failure for a learning model or approach. In addition, it plays a fundamental role in improving the quality of higher education institutions [7].

Student satisfaction has been studied in learning management systems [8], where it is defined as the extent to which students find the various components of the learning management system in online education meeting their expectations. Student satisfaction has also been investigated in the context of social media and its impact on academic performance [9], exploring satisfaction regarding technology utilization and pedagogy. Therefore, student satisfaction is the contentment or happiness experienced by students regarding the use of technology and is associated with factors such as the ease of use and usefulness of the systems. Alyoussef [10] supported this notion and conducted studies on the satisfaction levels with massive open online courses (MOOCs), emphasizing their significant role in predicting the performance of any technology.

2.2. Student engagement

According to Limniou et al. [11], a clear definition for student engagement is not available due to its diversity, complexity, and various dimensions. Student engagement is derived from motivation; therefore, this concept is often confused with motivation. Additionally, Gourlay et al. [12] highlighted that student engagement lacks theoretical grounding and exhibits contextual variations in its application. Thus, student engagement can refer to face-to-face activities on campus and online courses, being investigated often in the context of student-student, student-instructor, and student-content interactions [13].

Student engagement is the dedication, enthusiasm, and diligence students demonstrate in pursuing knowledge, encompassing behavioral, affective and cognitive aspects [14]. That is, student engagement includes factors such as attendance and class participation, interest, affinity, sense of community, and emotional connection with the learning environment and educators, concentration and attention towards study materials, effort to exceed expectations and their enjoyment of intellectual challenges.

2.3. Perceived instructor presence

Teachers establish a presence by assuming multiple roles in online learning environments [15]. The conceptual framework Community of Inquiry (CoI), used to enhance the quality of online learning experiences, defines three fundamental elements: social presence, teaching presence, and cognitive presence [16]. Social presence denotes the ability of learners and instructors to establish a sense of community and connection in the virtual environment. Cognitive presence refers to developing students' critical thinking and inquiry skills. While teaching presence is the most crucial component given that it integrates the social and cognitive presences to provide authentic online educational experiences [17]. It refers to the development and implementation of learning activities by the instructor. According to the CoI model, the interaction among these components is essential for fostering a rich and effective online learning experience.

Richardson et al. [18] highlighted that, in some cases, the term "instructor presence" is used interchangeably with "teacher presence," although these constructs are distinct from each other. Instructor presence is based on more observable instructional behaviors and actions than teacher presence. The instructor's presence becomes evident during live classes, as they are being conducted, rather than solely during the course design phase. This is important since instructors often teach courses they have not personally designed or developed. Thus, under the CoI model, instructor presence emerges from the convergence of social and teaching presence.

Glazier and Harris [19] found that students prefer face-to-face over online classes, where instructors are prominent. However, the findings also indicated that clear instructions and instructor availability are important factors in both modalities. In this sense, the analysis of instructor presence is of great relevance in research, given that some teachers offer online classes with inadequate presence, generating a sense of disconnection among students from their peers and the teachers themselves.

2.4. Interactive tools in education

Digital collaboration in higher education combines processes and tools to facilitate communication and interaction between educators and students. This is accomplished through the utilization of various software platforms and tools. According to Sternad Zabukovšek et al. [20], digital collaboration in higher education promotes connectivity between students and teachers, thereby increasing efficiency and promoting enhanced group dynamics and relationships within blended courses. For blended learning to be sustainable, they emphasize that students must embrace e-learning platforms and digital collaboration tools that facilitate interactivity.

In this sense, Camilleri & Camilleri [21] agreed and emphasized that virtual educational environments should be meticulously designed to provide students with the necessary tools to foster their reflective and critical thinking abilities. Incorporating interactive learning techniques and collaborative pedagogical approaches becomes crucial. Sushchenlo, Akhmedova, and Stryzak [22] further emphasized that interactive teaching methods are fundamental in preparing students with the necessary professional skills to effectively apply their theoretical knowledge to practical, real-world situations. Furthermore, using interactive learning technologies enables students to understand real-life scenarios and adapt their knowledge and skills to meet the demands of the business world.

Given the relevance of collaboration tools, such as Microsoft Teams, extensive research in this area has been conducted in the higher education environment. Investigations have focused on their usability as learning tools [23] and examined the social presence and potential gender differences in the learning experience [24].

2.5. The link between interactive tools, perceived instructor presence, student satisfaction and student engagement

The literature indicates a positive correlation between the interactivity of communication tools and the perceived presence of the instructor. Moreover, it demonstrates the positive impact of instructor presence on student engagement and satisfaction, as well as the impact of engagement on student satisfaction [2,3]. According to Farrell & Brunton [25], one way to encourage social interaction and improve presence in online courses is to incorporate design elements that facilitate active communication between students and teachers. This can be achieved through asynchronous discussion forums and synchronous online classes. By implementing these strategies, instructors can create an engaging and collaborative learning environment that promotes meaningful interactions and fosters a strong sense of community among students. The interactive tools utilized to deliver the courses play a fundamental role in this process.

Hollister et al. [13] concluded that students can actively engage with online learning when instructors employ appropriate tools. Holmes & Prieto-Rodríguez [26] explain that the effectiveness of learning management tools enables interactivity in online and hybrid courses. Therefore, the choices that educational administrators and managers make when deciding which learning tools to use to maximize student engagement and learning are significantly important. Farrell and Brunton [25] highlighted that positive learning experiences, course completion, and a sense of satisfaction are among the outcomes of online student engagement. On the other hand, student disengagement results in failure to complete studies, withdrawal and poor learning experiences. Thus, even when a course is completed with low levels of student engagement, the learning experiences tend to be poor, and dropout risks are high.

In the work of Thanasi-Boçe [27], conducted during the pandemic, it was found that motivation, interaction, and the role of the instructor positively affected positive perceptions of online learning, resulting in satisfaction. Interaction was the factor with the greatest impact on creating perceptions of online learning. The impact of instructors on learner motivation was also greater if there was more interaction on the online learning platform.

Online learning is becoming increasingly popular around the world, particularly in the aftermath of the COVID-19 pandemic [28]. Even though the hybrid modality generates additional issues of student engagement, hybrid classes are becoming an essential part of the post-COVID-19 education stage [29]. Hybrid educational models are not new, although some people just discovered them after the pandemic. With the educational post-pandemic scenario, many adjustments are being implemented to incorporate online or hybrid learning models into regular instruction [30]. As we embrace these changes in education, the hybrid and online learning landscapes reflect an adaptation to contemporary learner needs, opening the way to an era in which flexible, technology-supported educational models are critical to the future of learning.

3. Materials and methods

3.1. Context of the study

After the lockdown period, in February 2022, a gradual and selective transition to face-to-face classes was implemented at the university where the study was conducted. Throughout the spring 2022 term, some groups of students attended the campus in person on specific days, while others continued with their classes online. Subsequently, the roles were reversed to ensure that each student had the opportunity to attend the campus for a minimum of two days per week. It is important to note that during this period, there was flexibility regarding in-person absences. These measures were implemented to manage the maximum capacity permitted in classrooms and, thus, prevent the spread of COVID-19.

However, it was not until the autumn of 2022 that face-to-face classes were fully reinstated for all groups, except on Fridays. From Monday to Thursday, classes were conducted face-to-face, while on Fridays, all classes were virtual and synchronous through Microsoft Teams. During this period, there was no tolerance for in-person absences. However, even in on-campus classes, all sessions were recorded on Teams and made available for later reference. Teams was utilized throughout the week for exercises, activities,

consultancies, homework, and communication between students and professors. Thus, the fall of 2022 was the first hybrid school term after the lockdown. Therefore, this study focused exclusively on this period, surveying students to gather their perceptions and experiences regarding education.

In every subject, the face-to-face lecture sessions had a duration of 2 h and a frequency of twice a week. The virtual synchronous sessions that took place only on Fridays of each week through Microsoft Teams had a duration of 1 h. In each session, each instructor managed the time and activities according to their criteria and the agenda for that subject. No specific instructions were given to either students or instructors. The classes were conducted in a natural manner, free of manipulation by the researchers.

This context was chosen because of the relevance of hybrid education after the lockdown. In addition, in Mexico, students at various educational levels spent more than two years in educational confinement. For this reason, research in this setting is still scarce and can provide cultural and unique references that are of interest on an international scale. In addition, studies in this context contribute to the wide diversity of existing literature by providing an understanding of post-pandemic global education through concrete results that can be taken into account in other international educational contexts.

3.2. Population and sample

Data were collected from 1086 university students enrolled in four different undergraduate educational programs at a public state university in north-eastern Mexico, ensuring that the sample distribution was proportionate to the respective percentages of students in the population. Only four of the five educational programs taught at the university where the study was conducted were included in this study. The law program was not selected since its time allocations for the sessions were different in this period of hybrid education after the lockdown. Hence, we sought to maintain a homogeneous landscape for this research. The population details and the sample characteristics are presented in Table 1.

According to Kock [31], considering its characteristics, the minimum sample size that must be obtained for this study is 117 based on the inverse square root method and 104 according to the Gamma-Exponential Method. The parameters considered are Minimum absolute significant path coefficient = 0.23, Significance level = 0.05, and Power level = 0.800. The number of participants in this study satisfies the minimum requirements for the overall sample and the analyzed educational programs.

3.3. Instrument

The data collection instrument implemented was adapted from the work presented by Roque-Hernández et al. [3], who demonstrated its validity and reliability. The instrument comprises four sections: Interactivity in the communication tool (TEAMS), perceived instructor presence (PIP), student engagement (ENG), and student satisfaction (SAT). Responses to each item were collected using a five-point Likert scale, where one represented the lowest score and five the highest. The wording and identification code of each item are presented in Roque-Hernández et al. (2023) and in the supplementary materials.

The reliability and validity of the questionnaire were assessed through Composite Reliability values (CR), Average Variance Extracted (AVE), Heterotrait-Monotrait (HTMT) and HTMT2 correlation coefficients. The procedures and resulting values are presented in the data analysis approach and the results sections.

The electronic questionnaire was developed using Microsoft Forms, and a hyperlink was generated and shared with the students enrolled in the analyzed academic programs via Microsoft Teams. Data collection took place post-pandemic for four weeks during March 2023. All the questions referred to the educational experiences encountered in the fall 2022 school term.

3.4. Data analysis approach

Once the participants' responses were collected through Microsoft Forms, the file was downloaded in .xlsx format and inspected using Microsoft Excel. None of the questionnaires was excluded. There were no missing data since the questionnaire was designed to ensure that all questions were answered. In addition, the responses were coded numerically to facilitate subsequent statistical analyses. The resulting file was imported into Jamovi software (version 2.3.21). Initially, an exploratory analysis of the data was performed using frequency tables and descriptive statistics. Subsequently, a confirmatory factor analysis (CFA) was conducted to determine whether the factorial structure of the original questionnaire could be maintained for the collected dataset. The Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Standardized Root Mean Square Residual (SRMR) and Root Mean Square Error of Approximation (RMSEA) indicators were obtained, and the reference values shown in Table 2 were used.

Table 1
Characteristics of the population and the sample.

Educational program	Population: Number of enrolled students	Percentage of Total Population	Sample: Number of participants in this study.	Total percentage of the sample
Administration	642	29%	316	29%
Foreign trade	819	38%	421	39%
Public accounting	494	23%	216	20%
Information technology	218	10%	133	12%
Total	2173	100%	1086	100%

The data set was subsequently imported into the WarpPLS (version 8.0) for determining the Composite Reliability values, Average Variance Extracted (AVE), the heterotrait-monotrait (HTMT) and HTMT2 correlation coefficients, to assess internal consistency, convergent validity, and discriminant validity. Following the recommendation of Henseler et al. [32], the reference values used were: Composite reliability >0.7, AVE >0.05, and HTMT significantly less than 1. In addition, the HTMT2 indicator, an improved version of the HTMT [33], is considered good if it is < 0.90 and even better if it is < 0.85 [31]. Additionally, the absence of "Common Method Bias" was ensured by applying the Full Collinearity VIF (Variance Inflation Factor) method for each latent variable. A threshold of less than five was utilized, following the criteria set by Kock [34].

Structural equation modeling was also performed in WarpPLS. The "Factor-Based PLS Type CFM3" algorithm was used to analyze the structural model, and the "Linear" algorithm was used for the measurement model. The model fit values and quality indices were examined and presented in Table 3. It was ensured that the factor loadings of each item exceeded 0.70. Performance results were obtained, and total effects and effect sizes were calculated. Finally, a multigroup analysis was conducted to determine whether the results of the hypotheses proposed in this study were maintained across each of the educational programs. A multilevel analysis, as described in Kock [35], was also performed to examine whether belonging to a specific educational program had an impact on perceived instructor presence, student satisfaction and engagement.

4. Results

4.1. Confirmatory factor analysis

The confirmatory factor analysis yielded the following results: CFI = 0.963, TLI = 0.958, SRMR = 0.026, RMSEA = 0.069 (90% CI: 0.065–0.073). Based on this, it was determined that the model exhibited a good fit. Thus, the rest of the analyses were conducted using WarpPLS.

4.2. Reliability, validity and fit of the SEM

The fit and quality indices of the SEM were evaluated (see Table 3), along with the reliability, validity, explained variance, multicollinearity, and predictive relevance of each latent variable (see Table 4). The HTMT and HTMT2 indices were also analyzed for each latent variable (see Table 5).

4.3. Results of SEM

Table 6 presents the factor loadings of the items in their respective factors, with all factor loadings exceeding 0.70. The results of executing the complete model are presented in Fig. 2, indicating that all the Beta coefficients were significant. However, the effects and effect sizes are presented in Table 7, where it can also be observed that all the effects were statistically significant.

4.4. Analysis of the influence of educational programs on the outcomes

The study confirmed the four hypotheses proposed for the Administration, Foreign Trade, and Public Accounting educational programs. However, in the case of the Information Technology program, hypotheses H1, H2, and H4 were found to be significant at the 0.01 level. In comparison, hypothesis H3 did not reach significance at the 0.01 or 0.05 level, although it showed significance at the 0.10 level as shown in Table 8.

However, the multilevel analysis revealed that the educational program did not significantly impact ($p > 0.05$) any of the endogenous variables of the model: the perceived presence of the instructor, student engagement, or student satisfaction.

5. Discussion

The results indicate a positive impact of communication tool interactivity on the perceived presence of the instructor, which successively, has positively influenced student satisfaction and student engagement. Additionally, student engagement directly affects student satisfaction. That is, the interactive communication tool and the perceived presence of the instructor play an important role in hybrid learning environments, promoting student participation and contributing to their satisfaction. Both student engagement and

Table 2
Reference values utilized in this study.

Value	Cutoff values	Meaning	Reference
RMSEA	<0.05	Good fit	[36]
	0.05 to 0.08	Acceptable fit	
	0.08 to 0.10	Marginal fit	
SRMR	<0.05	Acceptable fit	[32]
	<0.08	More adequate for PLS models	[32]
CFI, TLI	>0.90	Acceptable	[37]
	>0.95	Good	[38]

Table 3
Quality indices calculated using WarpPLS.

Quality indices	Result	Standard thresholds [31]
APC -Average Path Coefficient-	0.599***	
ARS -Average R-squared-	0.617***	
AARS -Average Adjusted R-Squared-	0.617***	
AVIF -Average Block VIF-	2.158	admissible when ≤5, preferably ≤3.3
AFVIF -Average Full Collinearity VIF-	3.6	Admissible when ≤5, preferably ≤3.3
GoF -Tenenhaus GoF-	0.686	large when ≥0.36
SPR -Simpson's Paradox Ratio-	1.000	Admissible when ≥0.7, preferably = 1
RSCR -R Squared Contribution Ratio-	1.000	Admissible when ≥0.9, preferably = 1
SSR -Statistical Suppression Ratio-	1.000	Admissible when ≥0.7
NLBCDR -Nonlinear Bivariate Causality Direction Ratio-	1.000	Admissible when ≥0.7
SRMR -Standardized Root Mean Squared Residual-	0.029	Admissible when ≤0.1
SMAR -Standardized Mean Absolute Residual-	0.023	Admissible when ≤0.1
SChS -Standardized Chi-Squared with 209 Degrees of Freedom-	0.295***	
STDCR -Standardized Threshold Difference Count Ratio -	1.00	Admissible when ≥0.7, preferably = 1
STDSR -Standardized Threshold Difference Sum Ratio-	1.00	Admissible when ≥0.7, preferably = 1

***$p < 0.001$.

Table 4
Indicators and properties of latent variables calculated using WarpPLS.

	TEAMS	PIP	SAT	ENG
R-squared coefficient		0.527	0.789	0.537
Adjusted R-squared coefficients		0.527	0.788	0.536
Composite reliability coefficients	0.919	0.954	0.974	0.900
AVE	0.74	0.775	0.844	0.692
Full collinearity VIF	2.2	3.0	4.8	4.5
Q-squared coefficients		0.527	0.788	0.537

Table 5
HTMT and HTMT2 radios calculated in WarpPLS.

	TEAMS	PIP	SAT	ENG
TEAMS				
PIP	0.729*** (0.729***)			
SAT	0.653*** (0.652***)	0.746*** (0.746***)		
ENG	0.623*** (0.620***)	0.733*** (0.732***)	0.872*** (0.870***)	

Values are presented in the following format: HTMT (HTMT2). *** indicates that $p < 00.001$.

satisfaction are desirable in post-pandemic hybrid scenarios, especially considering the prolonged period of remote education during the lockdown, resulting in feelings of isolation and unfavorable academic outcomes. Thus, the effective utilization of interactive tools and the active presence of instructors in their courses are two crucial elements that significantly enhance the teaching-learning processes.

The research hypotheses were supported by analyzing the data collected and by analyzing each academic program was analyzed separately. Only in the case of the Information Technology was it found that there was a significant influence of the perceived presence of the instructor on student satisfaction (H3) at a confidence level of 90%.

The findings of this study on the post-lockdown period are consistent with those obtained before [2] and during [3] the COVID-19 lockdown, suggesting that interactive communication tools have been and will continue to be relevant in the different educational contexts and modalities. This study contributes to understanding how interactive communication tools and instructor presence can improve hybrid teaching-learning processes in the post-pandemic era. The findings highlight the significance of perceived instructor presence in influencing student satisfaction and engagement and the effectiveness of Microsoft Teams in facilitating those outcomes.

The findings of this study can be related to more comprehensive educational frameworks. For example, the relationship among instructor presence, interactive communication tools, student satisfaction and student engagement is aligned with socio-constructivist theories of learning. These theories emphasize that knowledge is constructed by the learner in an active, interactive and social process. Thus, in this process, collaboration and interaction are fundamental.

On the other hand, the interactivity provided by technological tools such as Microsoft Teams facilitates collaborative learning through meaningful interactions among course participants. This is also aligned with educational theories that emphasize the social nature of learning. Therefore, these tools allow students to work together on activities and projects to achieve a deeper understanding in a framework of effective communication where their social skills are developed and their prior knowledge is leveraged.

This research contributes significantly to the area of educational research by presenting a contemporary perspective on the

Table 6
Factor loadings calculated using WarpPLS.

	TEAMS	PIP	SAT	ENG
TEAMS1	0.801			
TEAMS2	0.898			
TEAMS3	0.894			
TEAMS4	0.845			
PIP1		0.858		
PIP2		0.900		
PIP3		0.857		
PIP4		0.899		
PIP5		0.868		
PIP6		0.899		
SAT1			0.934	
SAT2			0.927	
SAT3			0.903	
SAT4			0.924	
SAT5			0.924	
SAT6			0.891	
SAT7			0.927	
ENG1				0.803
ENG2				0.770
ENG3				0.878
ENG4				0.872

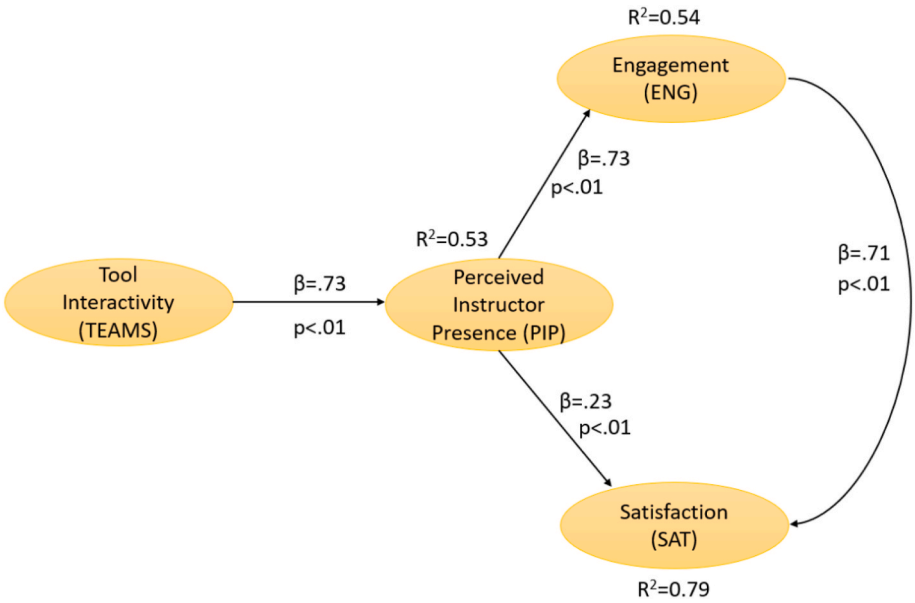

Fig. 2. Results of the SEM analysis performed in WarpPLS.

Table 7
Total effects and effect sizes calculated using WarpPLS.

	TEAMS	PIP	SAT	ENG
PIP	0.726*** (0.527)			
SAT	0.542*** (0.353)	0.746*** (0.557)		0.707*** (0.618)
ENG	0.532*** (0.332)	0.733*** (0.537)		

***$p < 0.001$, data in parentheses represent effect sizes.

interrelationship of interactive communication tools, instructor presence, engagement and student satisfaction in post-pandemic hybrid learning environments. The novelty of this work lies in its detailed analysis of these dynamics in the cultural and educational context of a public state university in Mexico. By using Microsoft Teams as an interactive communication tool, the research reveals the platform's effectiveness in facilitating instructor presence and fostering positive student outcomes. Consideration of

Table 8
Results of Hypotheses for Analyzed Educational Programs performed in WarpPLS.

Educational program	H1	H2	H3	H4
Administration	β = 0.76**	β = 0.68**	β = 0.23**	β = 0.69**
Foreign trade	β = 0.69**	β = 0.76**	β = 0.24**	β = 0.69**
Public accounting	β = 0.76**	β = 0.79**	β = 0.26**	β = 0.70**
Information technology	β = 0.73 **	β = 0.68**	β = 0.12 (p = 0.07)	β = 0.80**

**$p < 00.01$.

program-specific variations further extends the novelty, recognizing that the influence of these factors is prevalent across different academic disciplines. Thus, this work provides a valuable framework for instructors, administrators, leaders, and researchers seeking to improve teaching and learning experiences in hybrid models.

6. Conclusion

In conclusion, the findings of this study support the notion that interactive communication tools, such as Microsoft Teams, play a fundamental role in enhancing post-pandemic hybrid teaching-learning in the university setting. The study revealed that utilizing these tools has a positive impact by improving the perceived presence of the instructor, which in turn increases student engagement and satisfaction. Moreover, it was found that higher levels of engagement are associated with higher levels of student satisfaction. This was evident in the diverse academic programs analyzed in this research.

The improvement in the perceived presence of the instructor promotes a greater connection and closeness between the teacher and the students, thus facilitating a more enriching learning environment. Interactive communication tools give students a heightened sense of involvement and engagement in classroom activities. This has been observed in pre-pandemic scenarios by Park & Kim [2], during the lockdown by Roque-Hernandez et al. [3] and during the post-pandemic hybrid education scenario in the present study.

The importance of this study in the post-pandemic context is highlighted, given that the adoption of hybrid educational approaches has become crucial. Interactive communication tools emerge as an effective solution for successfully implementing this educational modality since they enhance instructor presence and facilitate increased student participation.

This study has theoretical implications in the field of educational research. The relationships found in the model analyzed in this paper contribute to the evolving literature on technology-mediated learning environments. In addition, the work provides valuable information in the context of hybrid education post-lockdown by COVID-19, thereby contributing to the understanding of how to use technology to achieve a more efficient pedagogy.

From the perspective of managerial contributions, the study provides practical information that can be used by instructors, course designers, administrators, and leaders of educational institutions who wish to improve hybrid learning experiences. Our results suggest that educational institutions should pursue the integration of interactive tools in the design of their hybrid courses. Likewise, educational managers and administrators should invest in initiatives to train instructors with the knowledge, skills and values necessary to achieve an effective and efficient presence in their hybrid or online classes. This should be done without forgetting the human dimensions of their relationship with learners. These recommendations are in line with the current educational scenario, which is characterized by being complex and changing and where technology plays an important role.

It is important to acknowledge the limitations of this study when interpreting and generalizing the results. One limitation relates to the nature of the sample since it was collected from a single Mexican university, and the invitation was open to all students who wished to participate. Another limitation is the exclusive use of Microsoft Teams as an interactive communication tool. Likewise, a specific educational modality was evaluated: combining only two days of face-to-face sessions and one day of synchronous virtual classes per subject.

Future work can deepen the understanding of student engagement and satisfaction by studying the interactivity of the tools and the perceived presence of the instructor, for instance, examining the cognitive, affective, and behavioral dimensions. Likewise, it would be beneficial to break down satisfaction into other relevant dimensions, such as educational materials, teacher performance, technological elements, and relevance. In addition, future studies should consider incorporating elements such as academic performance and the frequency of class attendance into the model. The research could also be enriched by incorporating qualitative perspectives through in-depth interviews, allowing a mixed-methods research.

7. Ethics

Each participant gave their informed consent before answering the questionnaire. The research had the internal approval of the administration of the School of Commerce, Administration and Social Sciences of Nuevo Laredo for its implementation (2023-01). This project was evaluated by a team of expert researchers, who were external to this project, and has been deemed to present no risk to the participants. The institution and the researchers named in this document guarantee the ethical conduct of this research.

Data availability statement

Data can be available upon reasonable request.

CRediT authorship contribution statement

Ramón Ventura Roque Hernández: Writing – original draft, Supervision, Software, Investigation, Formal analysis, Conceptualization. **Adán López Mendoza:** Writing – review & editing, Validation, Resources, Investigation, Conceptualization. **Rolando Salazar Hernández:** Writing – review & editing, Software, Resources, Investigation, Conceptualization.

Declaration of competing interest

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

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e27342.

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