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The impact of teacher-student interactions on student engagement and satisfaction in blended learning environments: An exploratory study using multi-source data

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Abstract

Existing literature on blended learning in higher education predominantly relies on student surveys, offering a limited perspective on actual classroom dynamics. To address this gap, this study examines the mutual influence among teacher-student interaction, student engagement, and satisfaction within blended learning environments at a Chinese university. A mixed-methods approach was adopted, integrating three data sources: classroom observations, student perception surveys, and behavioral data from the Learning Management System (LMS), using a triangulation design to comprehensively explore the relationship between interaction quality and learning. The findings reveal that personalized feedback, especially the emotional support provided by teachers, is crucial for student satisfaction. While LMS data clearly reflect certain aspects of behavioral engagement, they show little correlation with students' affective engagement or perceived instructor support. Importantly, affective support not only strongly predicts student satisfaction but also appears to compensate for lower levels of online activity. These results suggest that in blended learning contexts, emotional and personalized interaction from instructors plays a vital role in fostering satisfaction, potentially outweighing the influence of online activity metrics. In practice, institutions and instructors should prioritize meaningful interpersonal engagement and affective feedback, rather than relying primarily on digital activity indicators, to enhance students' learning experiences and outcomes.

Keywords: Blended learning, Classroom observation, Emotional support, iFIAS, LMS data, Student engagement, Student satisfaction, Teacher-student interaction, Triangulation.

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Contents

Contribution of this paper to the literature
This study presents original research that has not been published previously. The work is solely that of the authors. The multi-source triangulation design, integrating direct classroom observation with survey and LMS log data to explore the emotional scaffolding in blended learning, represents a novel contribution to the field.

1. Introduction

Blended learning, characterized by the combination of face-to-face and web-based instruction, has become one of the most widely used teaching models in higher education due to the pervasive use of information and communication technologies. This form of delivery aims to promote more flexible, learner-centered educational experiences that allow students a higher degree of independence in their studies (Graham, 2019; Rasheed, Kamsin, & Abdullah, 2020). The key to the success of blended learning is the interaction between teachers and students, which is related to students' engagement and satisfaction (Kahu & Nelson, 2018; Martin & Bolliger, 2018).

A long-standing issue with work in this domain has been a reliance upon self-report measures such as surveys that mask the complexities of classroom interactions (Zhao, Wang, Li, & Zhou, 2021). However, there are many inconsistencies between perceived and actual behaviors by both students' perceptions and instructors' actions, which make it questionable whether conclusions drawn based on one set of data are reliable (Li, Chen, & Zhang, 2022; Quinlan, 2019). Although LMS logs represent an objective record of students' behaviors, such digital traces may not contain sufficient contextual information to understand the social and affective aspects of learners (Gašević, Tsai, Dawson, & Pardo, 2019). Thus, researchers have begun to call for the practice of methodological triangulation towards building better, richer understandings of the educational process (Wang, Li, & Su, 2023).

By operationalizing and relating essential constructs such as teaching presence, student engagement, and satisfaction across various data sources, this study aims to provide an integrative explanation of how interactions work in hybrid learning contexts. This paper follows with a series of research questions.

1. How do observable teacher-student interaction behaviors correlate with students' engagement?
2. What role does emotional support play in the relationship between students' digital engagement and satisfaction?
3. How does the triangulation of classroom observation, survey, and log data enhance our understanding of these interaction mechanisms?

2. Literature Review

Blended learning facilitates the personalization of instruction, enabling students to regulate the tempo and trajectory of their own learning through a combination of online and face-to-face activities (Graham, 2019). Personalized learning in this framework could also be used to improve engagement and performance (Xie, Hensley, Law, & Sun, 2019). However, technology is not a silver bullet: good teaching relationships are just as meaningful as the system itself, both teacher-student and student-student (Rasheed et al., 2020). These multifarious interactions among cognition, behavior, and emotion together compose the student learning experience (Kahu & Nelson, 2018). The CoI model helps to understand this as it suggests that a practical learning situation emerges through three components: Teaching, Social, and Cognitive presence (Garrison, Anderson, & Archer, 2010). The role of emotional support, which bridges teaching and social presence, is widely recognized as crucial for maintaining learning communities and promoting deeper engagement (Cleveland-Innes & Campbell, 2012; Rogers, 2019). At the same time, the field of learning analytics has advanced our ability to quantify student engagement from LMS logs (Gašević, Dawson, & Siemens, 2015). These digital traces offer an unobtrusive and scalable lens on behavioral engagement, tracking patterns of resource access and participation (Pardo, Jovanovic, Dawson, Gašević, & Mirriahi, 2019). However, this method is occasionally criticized for "behaviorist reductionism" as it does not always reflect the internal motivations or emotions underlying learning. A clear missing piece in the existing literature is works that systematically correlate such behavioral fingerprints with student self-reported outcomes and, importantly, with the immediate, observable interactions that occur in classrooms (Derakhshan, Wang, & Ghiasvand, 2024; Henrie, Halverson, & Graham, 2015). Ultimately, the convergence of these data sources is vital for validating engagement metrics and linking them to meaningful educational outcomes like Student satisfaction (Bond, 2020). Direct classroom observation captures the context and process of interaction, thereby complementing self-reports and digital logs and revealing the pedagogical and relational dynamics behind quantified behaviors (Hoadley & Campos, 2022; Hora, 2016; Li et al., 2022). Thus, the inclusion of classroom observation within a multi-source approach aims to contribute to a better contextualized and more comprehensive description of how interactions work in blended learning settings, addressing a direct need for methodological innovation in the field (Greene, Caracelli, & Graham, 1989).

3. Research Methods

The three main variables are the teacher-student interaction, students' engagement, and satisfaction. A sequential mixed-methods explanatory design was used, with triangulation of classroom observation, questionnaires, and LMS log analysis. The reasoning behind "qualitative preceding, quantitative succeeding" was that qualitative observations would inform the later interpretation and sense-making of the quantitative data from surveys and logs. We chose this approach to maximize the study's ecological validity as well as to enable us to conduct a multi-dimensional investigation of the interaction mechanism.

3.1. Research Design and Participants

This study took place at Yunnan University, located in Southwest China. Using stratified sampling, we recruited 300 undergraduate humanities students taking blended learning courses with at least two years of related experience as participants. After data cleansing (removing invalid questionnaires and LMS records that did not match), the final valid sample included 263 respondents (N=263). All students took an online hybrid course, meaning it was a

combination of face-to-face and SPOC classes. To maintain the highest possible standards of rigor, triangulation of the findings from three data sources (see Table 1) was used to create an analytical lens with multiple facets.

Table 1. Overview of triangulated data sources and measured indicators.

Data source	Format	Measured dimensions	Purpose
Classroom observation	iFIAS-coded real-time logs	- Instructor questioning - Feedback frequency - Emotional cues (e.g., praise, empathy) -Instructional directives - Learner response levels	Capture actual teaching behaviors and interaction dynamics
Student survey	Online LPILI instrument	- Instructional guidance - Social intimacy -Communication clarity - Instructor presence -Emotional and instructional support	Assess perceived teacher interaction quality and student satisfaction
LMS log data	System-generated metrics	- Total learning time (minutes) - Number of discussion posts -Assignment completion rate	Evaluate student engagement and online participation patterns

3.2. Research Instruments and Procedures

Classroom observation: Teacher-student interaction was codified by following the process of a modified version of Flanders' Interaction Analysis System (iFIAS). It covers all verbal (e.g., questions from the instructor) and nonverbal (e.g., clarity of responses to students' queries) instructional activities performed in a classroom (instructions, feedback, and indicators of emotional support). The classroom observations took place in face-to-face and online synchronous sessions of six blended classes. The interrater agreement between two trained raters was over 85%, ensuring objective and consistent coding of the study.

Student Questionnaire: The "Learning Presence and Interaction in Learning Instruments (LPILI) survey" was collected at the end of the course to measure student perceptions. This survey contains 25 items that cover five sub-dimensions and was used to measure student perception. Each item is answered by students using a five-point Likert response scale (1= strongly disagree; 5=strongly agree).

LMS Log Data: We collected behavioral data of a full teaching cycle in the university's centralized LMS system and linked them to our survey sample. These included, among other things, overall learning time on the platform, number of discussion posts (discussion participation), and assignment completion rate. All data were anonymized before analysis.

3.3. Data Collection Process

This study was approved by the Institutional Review Board (IRB) of Human Ethics Committee, Taylor's University, under protocol number HEC 2025/159, dated 9th May 2025. Informed verbal consent was obtained from all participants, and all data were anonymized to protect participant confidentiality.

The data were collected in three stages:

(1) Non-intrusive classroom observation of students' activities in their normal setting.

(2) Delivery of the electronic questionnaire towards the end of the semester.

(3) Extraction of the associated LMS log files.

3.4. Data Analysis

We employed a mixed methods approach to data analysis. Descriptive statistics were conducted for all variables. To examine possible associations between observed teaching behaviors and reported levels of student engagement, we calculated correlations (Pearson's r) among relevant pairs of variables. Lastly, using multiple regression, we examined whether students' perceived levels of satisfaction with their teachers' instructional approaches were associated with specific patterns in their use of the online discussion board. Most importantly, triangulation analysis involved a comparative evaluation of observational, survey, and log data to identify convergent, complementary, and divergent patterns, leading to a better overall understanding. Lastly, the exploratory Structural Equation Modeling (SEM) mapping of possible pathways between teaching behavior, student engagement, and satisfaction. In all cases, we found that the qualitative data obtained through classroom observation were invaluable in interpreting the quantitative data.

4. Research Findings

4.1. Classroom Observation Results on Teacher-Student Interaction

When we analyzed the set of coded observations for each class using the iFIAS coding, one theme emerged across all cases: the instructors were talking for most of the class. In Classes 1-1 and 1-2, lecturing took up 73.48% and 66.84% of instructor speaking time, respectively (Table 2). Behaviors that denote emotional support or active student participation were rare in comparison.

The visualizations of interactions during one class period (40 minutes long), Figures 1 and 2, also showed an instructor-centric paradigm with more activity at the beginning and end of each class. During the middle phase of the class, peaks in learner engagement align with decreased instructor talk and increased supportive technical operations.

Overall, interactions remain consistent with only brief, scattered moments of silence.

Table 2. Distribution of interaction types in class 1-1 and class 1-2.

Major categories	Sub-categories	Frequency	%	Frequency	%
		Class 1-1		Class 1-2	
Instructor interaction behavior	Instructor acceptance of emotion	35	4.53%	15	1.92%
	Instructors praise and encourage	0	0%	0	0%
	The instructor adopted the learners' point of view	0	0%	6	0.77%
	Instructors' questioning	39	5.05%	50	6.40%
	Lecturing content	568	73.48%	522	66.84%
	Instructional directives	37	4.79%	37	4.74%
	Instructor criticism and upholding the authority	0	0%	0	0%
Learner interaction behavior	learners' Passive response	7	0.91%	5	0.64%
	Active response	28	3.62%	61	7.81%
	Discuss with a partner	0	0%	0	0%
Silence	Contribute little to class teaching	0	0%	2	0.26%
	Contribute to class teaching	13	1.68%	40	5.12%
Technical operations	Instructor manipulation technique	38	4.92%	32	4.10%
	Learner manipulation Technique	8	1.03%	11	1.41%
	Total	773	100%	781	100%

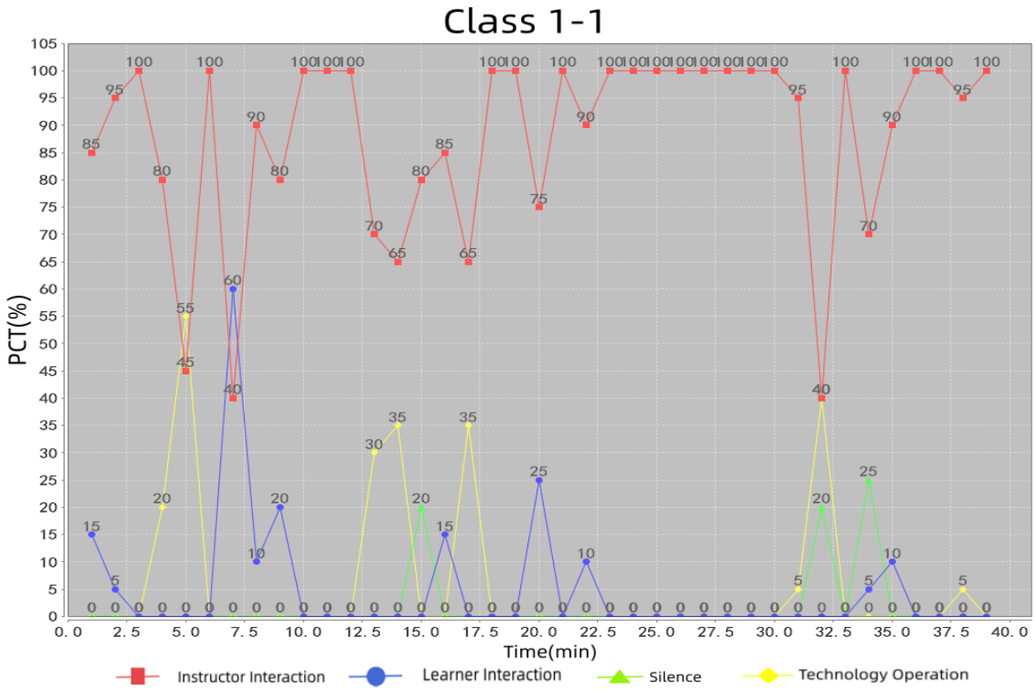

Figure 1. Instructor and learner interaction dynamics in class 1-1.

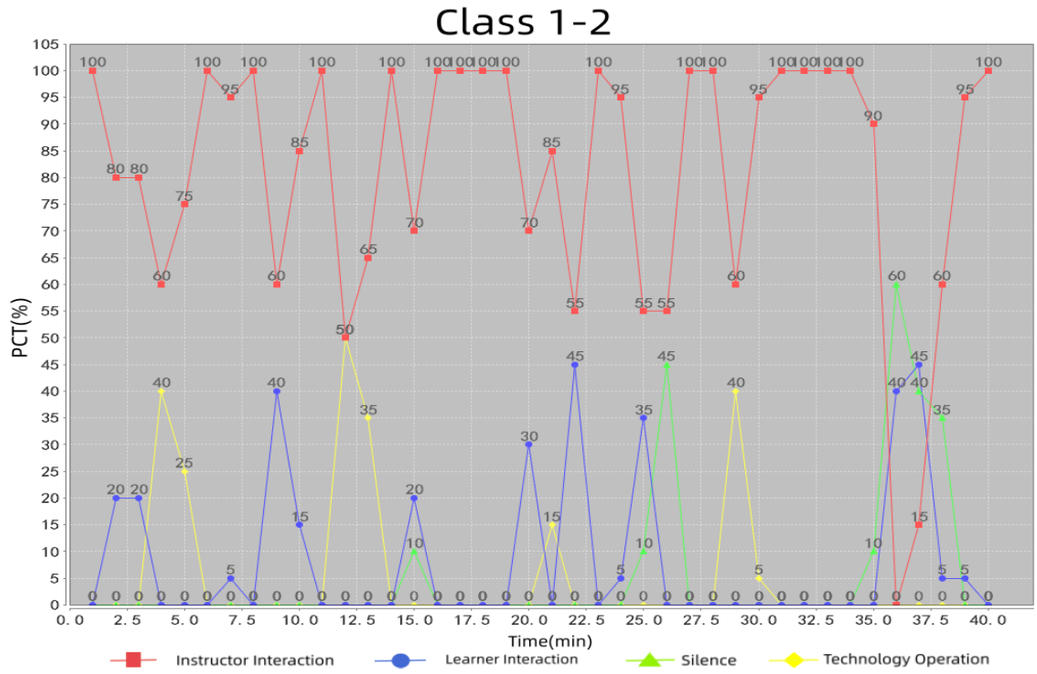

Figure 2. Instructor and learner interaction dynamics in class 1-2.

Figure 2 illustrates the interaction timeline for a 40-minute session. Instructor speech predominates throughout, consistent with quantified lecture time. A sustained period of heightened learner participation occurs between the 7 to 25 minutes marks, representing a distinct phase of increased activity within the overall instructor-led structure.

Class 2 and 3 also showed some variation in terms of structure although not for the basic dynamics: Class 2-1 still had the domination by lecturing (31.50%) albeit on a lower rate, whereas it increased to 63.89% and accounted for a significant percentage of time spent on "Learner Technology Use" (i.e., 26.76%) within Class 2-2 (Table 3) where SPOC-platform activity became more prevalent.

Table 3. Distribution of interaction types in Class 2-1 and Class 2-2.

Major categories	Sub-categories	Frequency	%	Frequency	%
		Class 2-1		Class 2-2	
Instructor interaction behavior	Instructor acceptance of emotion	0	1.41%	0	0%
	Instructors praise and encourage	0	0.77%	0	0%
	The instructor adopted the learners' point of view	0	1.28%	37	4.74%
	Instructors' questioning	0	17.16%	7	0.90%
	Lecturing content	554	31.50%	499	63.89%
	Instructional directives	14	4.23%	16	2.05%
	Instructor criticism and upholding the authority	3	0%	0	0%
Learner interaction behavior	Learners' Passive Response	0	8.96%	0	0%
	Active response	0	19.72%	0	0%
	Discuss with a partner	0	0.64%	0	0%
Silence	Contribute little to class teaching	7	3.84%	0	0%
	Contribute to class teaching	6	8.07%	12	1.54%
Technical operations	Instructor manipulation technique	196	2.30%	209	26.76%
	Learner manipulation technique	1	0.13%	1	0.13%
	Total	781	100%	781	100%

Figure 3. Instructor and learner interaction dynamics in class 2-1.

Figure 3 illustrates the interaction breakdown for Class 2-1, showing that lecturing accounts for 31.5%. The graph also highlights significant portions for questioning (17.16%) and instructional directives (4.23%), indicating a teaching approach focused on teacher-student dialogue and direct guidance.

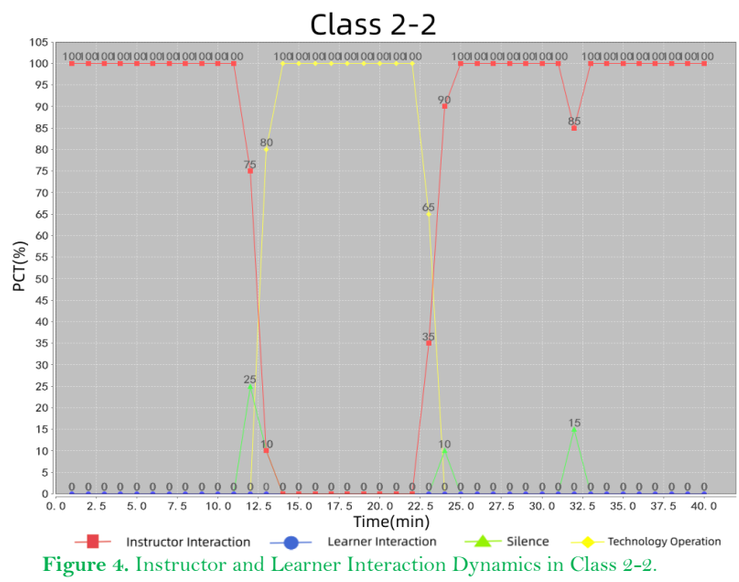

Figure 4. Instructor and Learner Interaction Dynamics in Class 2-2.

Figure 4 displays the interaction distribution for Class 2-2, in which lecturing accounts for a substantial proportion (63.89%). The chart further highlights the share of "learner manipulation techniques" (26.76%), while student engagement remains relatively low at 19.72%, reflecting an instructional model centered on lecturing and technical skill training.

Class 3 exhibited a much higher rate of engagement with students, but lecturing was still dominant, and tech tasks frequently interrupted academic conversation (Tables 4, Figures 5-6). In each class, there was frequent silence or quiet discussion, highlighting a practical issue: How can we design more standardized, student-centered interactions that strike a balance between practicing tasks and engaging in substantial academic conversations?

Table 4. Distribution of Interaction Types in Class 3-1 and Class 3-2.

Major Categories	Sub-Categories	Frequency	%	Frequency	%
		Class 3-1		Class 3-2	
Instructor interaction behavior	Instructor acceptance of emotion	11	1.41%	11	1.41%
	Instructors praise and encourage	6	0.77%	17	2.18%
	The instructor adopted the learners' point of view	10	1.28%	3	0.38%
	Instructors' questioning	134	17.16%	100	12.80%
	Lecturing content	246	31.50%	200	25.61%
	Instructional directives	33	4.23%	28	3.95%
	Instructor criticism and upholding the authority	0	0%	0	0%
Learner interaction behavior	Learners' Passive Response	70	8.96%	33	4.23%
	Active response	154	19.72%	136	17.41%
	Discuss with a partner	5	0.64%	85	10.88%
Silence	Contribute little to class teaching	30	3.84%	4	0.51%
	Contribute to class teaching	63	8.07%	1	0.13%
Technical operations	Instructor manipulation technique	18	2.30%	64	8.19%
	Learner manipulation technique	1	0.13%	99	12.68%
	Total	781	100%	781	100%

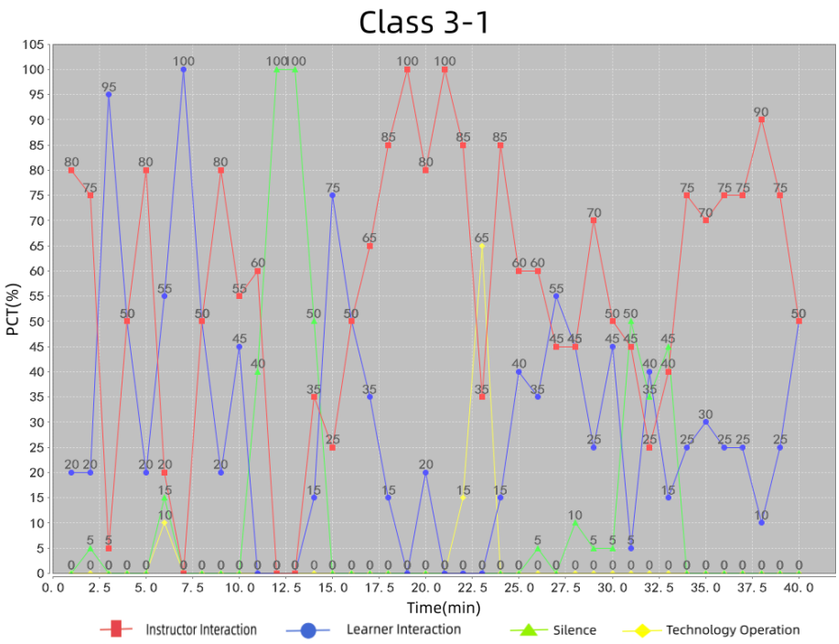

Figure 5. Instructor and Learner Interaction Dynamics in Class 3-1.

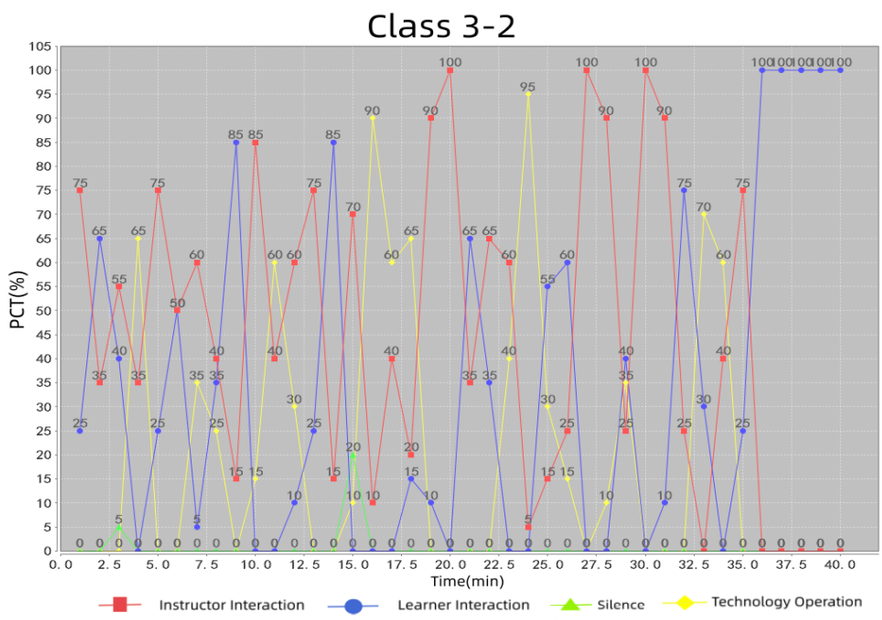

Figure 6. Instructor and Learner Interaction Dynamics in Class 3-2.

4.2. Analysis of Student Perception

The survey showed students generally felt positive about the learning environment and teacher-student interactions. Mean scores across key perceptual dimensions were consistently high: Guidance and Facilitation (M = 4.32, SD = 0.72), Social Intimacy (M = 4.17, SD = 0.85), Instructional Communication (M = 4.30, SD = 0.75), Instructor Presence (M = 4.19, SD = 0.81), and Instructional Support (M = 4.26, SD = 0.73).

Overall student satisfaction was also rated highly (M = 4.18, SD = 0.74). Students with more frequent positive interactions reported higher satisfaction, highlighting the importance of clear guidance, effective communication, and consistent support.

4.3. Analysis of Student Engagement (LMS Data)

Students with more positive interactions reported higher student satisfaction, underscoring the value of clear guidance, communication, and consistent support (Table 5).

Table 5. Cluster composition (K-means result).

Cluster	% of Students	Learning Time (M)	Posts (M)	Tasks Completed (M)
Minimal users	28.10%	142	1.2	2.1
Selective participants	41.40%	203	2.9	4.4
Active participator	30.40%	287	8.3	4.8

Note: M = mean.

Low Discussion (28.1%): These learners spend limited time studying, participate minimally or not at all in discussion forums, and often leave assignments unfinished. Selective Participants (41.4%): These students dedicate a moderate amount of time to learning and consistently complete their tasks, though they tend to engage less in discussions. Engaged Users (30.4%): These individuals demonstrate strong and ongoing involvement across all aspects of regular study habits, active participation in discussions, and high assignment completion rates.

Interestingly, however, there were no significant between-group differences in their reported level of satisfaction with this behavior ($F(2, 260) = 1.21$, $p > 0.05$). Active Participants showed the highest mean value for student satisfaction (M = 4.22), while Selective Participants were quite comparable (M = 4.18). Some of the Minimal Users indicated that they felt very satisfied. This disconnect implies that the level of online participation does not directly translate to perceived course quality, suggesting that other variables are at work (e.g., in-person supports).

4.4. Correlation Analysis

Pearson's correlations produced clear patterns. Perceived teacher-student interaction correlated with a very strong, positive relationship to satisfaction ($r = 0.91$, $p < 0.01$). Correlations of LMS behavioral indicators (learning time, posts) with student satisfaction were weak and not significant ($r \approx 0.05$). Further, the relationship of self-reported experience with interactivity to observed behavior was trivial (r from -0.03 to 0.03). This suggests that the students' perception of the level of instructor support is an essentially separate dimension from their positive perception of their own level of online activity.

4.5. Exploratory Regression Modeling

The multiple regression model that predicted the student satisfaction using the five teaching presence dimensions is highly significant, $F(7, R^2 = 0.859)$, with Instructional Support ($\beta = 0.542$, $p < 0.001$) being most influential, then Instructor Presence ($\beta = 0.189$, $p < 0.001$) and Social Intimacy ($\beta = 0.147$, $p < 0.001$), while also "Guidance and Facilitation" made an impact albeit lower one ($\beta = 0.085$, $p = .047$). The only surprising result was that Teaching Communication had the weakest negative prediction ($\beta = -0.091$, $p = 0.045$), suggesting that, in combination with other supports, pure communication frequency may sometimes include stressors such as information overload.

By comparison, separate regressions, in which these interaction dimensions did not significantly predict any of the three indicators of student engagement, reinforce the conclusion that there is a disconnect between perceived quality and what one does online.

4.6. Structural Equation Modeling (SEM) Analysis

An SEM for the three latent variables Teacher-Student Interaction, student engagement, and satisfaction yielded an acceptable fit to the data (CFI = 0.94, TLI = 0.92, RMSEA = 0.05). Path coefficients (Figure 7) indicated that: 1) Interaction significantly positively predicted student engagement ($\beta = 0.55$, $p < 0.001$); 2), which in turn positively predicted student satisfaction ($\beta = 0.42$, $p < 0.05$); and 3) the direct effect of Teacher-Student Interaction on student satisfaction remained significant as well ($\beta = 0.33$, $p < 0.05$). Thus, we find support for the partial mediation model in which Teacher-Student interaction enhances student satisfaction through direct as well as indirect effects via increased engagement.

Figure 7 presents the structural equation model that outlines the relationships between Teacher-Student Interaction, student behavioral engagement, and student satisfaction. The model specifies that Teacher-Student Interaction, encompassing dimensions such as guidance, social intimacy, instructional communication, and instructional support, has a strong direct effect on student behavioral engagement ($\beta = 0.55$). Engagement, in turn, positively influences student satisfaction ($\beta = 0.42$), while Teacher-Student Interaction also maintains a significant direct effect on satisfaction ($\beta = 0.33$).

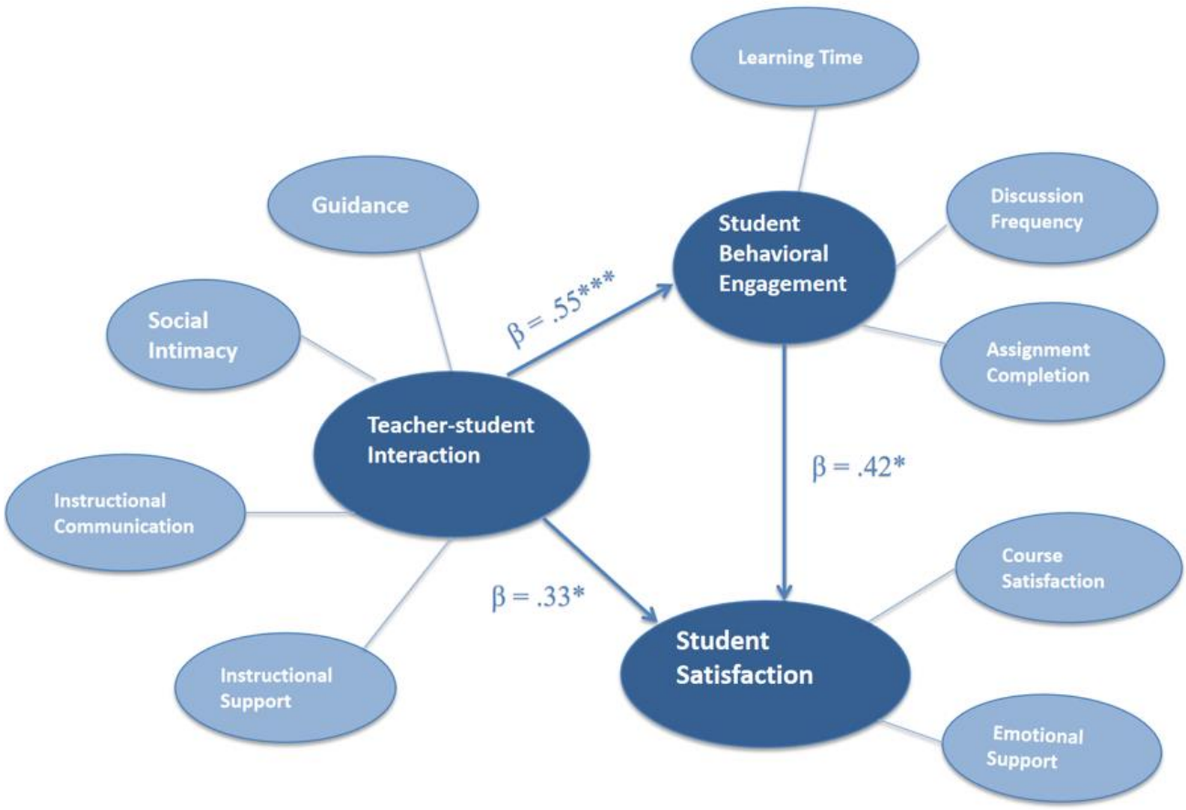

Figure 7. Graphical depiction of the SEM structure.

Note: In the figure, * indicates statistical significance at $p < 0.05$, and *** indicates statistical significance at $p < 0.001$.

5. Conclusion

This study, through its multi-source triangulation design, clarifies the dual pathways by which teacher-student interactions shape the hybrid learning experience. The central finding is that pedagogical and emotional support are core to student satisfaction, whereas raw behavioral data from LMS platforms show only a tenuous link. The structural equation model empirically validated that teacher-student interactions enhance student satisfaction both directly and through promoting student engagement.

In terms of theory, we first and foremost propose "emotional scaffolding" as an explicit construct that calls for the intentional creation of emotional support as part of an expanded notion of teaching presence within the CoI. In terms of methodology, the paper demonstrates and confirms the integration of observational, subjective, and digital data through triangulation, providing a practical framework for addressing limitations in single-source studies.

The present study is limited to a single institution and uses a cross-sectional design; thus, we caution against overgeneralization and call for further validation in other settings. Future studies should explore how "emotional scaffolding" can be applied beyond this context (i.e., across disciplines), examine how new technology (e.g., affective computing) may provide emotional support, and include learner attributes such as motivation to identify differential effects of interactions.

Finally, developing successful blended learning experiences will require more than just an emphasis on content delivery and platform metrics; they will need intentional planning for and incorporation of quality, emotionally supportive teaching interactions. We call on teachers and researchers to develop more comprehensive, caring approaches that truly support students' cognitive and emotional growth in this new era.

References

Bond, M. (2020). Facilitating student engagement through the flipped learning approach in K-12: A systematic review. *Computers & Education, 151*, 103819. https://doi.org/10.1016/j.compedu.2020.103819

Cleveland-Innes, M., & Campbell, P. (2012). Emotional presence, learning, and the online learning environment. *The International Review of Research in Open and Distributed Learning, 13*(4), 269–292. https://doi.org/10.19173/irrodl.v13i4.1234

Derakhshan, A., Wang, Y., & Ghiasvand, F. (2024). Reconceptualizing L2 teacher feedback literacy in the new era: A systematic review. *System, 121*, 103227.

Garrison, D. R., Anderson, T., & Archer, W. (2010). The first decade of the community of inquiry framework: A retrospective. *The Internet and Higher Education, 13*(1-2), 5-9. https://doi.org/10.1016/j.iheduc.2009.10.003

Gašević, D., Dawson, S., & Siemens, G. (2015). Let's not forget: Learning analytics are about learning. *TechTrends, 59*(1), 64–71. https://doi.org/10.1007/s11528-014-0822-x

Gašević, D., Tsai, Y.-S., Dawson, S., & Pardo, A. (2019). How do we start? An approach to learning analytics adoption in higher education. *International Journal of Information and Learning Technology, 36*(4), 342–353. https://doi.org/10.1108/IJILT-02-2019-0024

Graham, C. R. (2019). Current research in blended learning. In M. G. Moore & W. C. Diehl (Eds.), Handbook of distance education. In (4th ed., pp. 173–188). New York: Routledge.

Greene, J. C., Caracelli, V. J., & Graham, W. F. (1989). Toward a conceptual framework for mixed-method evaluation designs. *Educational Evaluation and Policy Analysis, 11*(3), 255–274. https://doi.org/10.3102/01623737011003255

Henrie, C. R., Halverson, L. R., & Graham, C. R. (2015). Measuring student engagement in technology-mediated learning: A review. *Computers & Education, 90*, 36–53. https://doi.org/10.1016/j.compedu.2015.09.005

Hoadley, C., & Campos, F. C. (2022). Design-based research: What it is and why it matters to studying online learning. *Educational Psychologist, 57*(3), 207–220. https://doi.org/10.1080/00461520.2022.2079128

Hora, M. T. (2016). *Beyond the skills gap: Preparing college students for life and work.* Cambridge, MA: Harvard Education Press.

Kahu, E. R., & Nelson, K. (2018). Student engagement in the educational interface: Understanding the mechanisms of student success. *Higher Education Research & Development, 37*(1), 58–71. https://doi.org/10.1080/07294360.2017.1344197

Li, X., Chen, B., & Zhang, H. (2022). Examining the perceptual gaps between students' self-reported interactions and observed teacher behaviors in blended learning environments. *Computers & Education*, *179*, 104392.

Martin, F., & Bolliger, D. U. (2018). Engagement matters: Student perceptions on the importance of engagement strategies in the online learning environment. *Online Learning*, *22*(1), 205-222. https://doi.org/10.24059/olj.v22i1.1092

Pardo, A., Jovanovic, J., Dawson, S., Gašević, D., & Mirriahi, N. (2019). Using learning analytics to scale the provision of personalised feedback. *British Journal of Educational Technology*, *50*(1), 128–138. https://doi.org/10.1111/bjet.12592

Quinlan, K. M. (2019). What triggers students' interest during higher education lectures? Personal and situational variables associated with situational interest. *Studies in Higher Education*, *44*(10), 1781–1792. https://doi.org/10.1080/03075079.2019.1665325

Rasheed, R. A., Kamsin, A., & Abdullah, N. A. (2020). Challenges in the online component of blended learning: A systematic review. *Computers & Education*, *144*, 103701. https://doi.org/10.1016/j.compedu.2019.103701

Rogers, C. R. (2019). *Freedom to learn* (3rd ed.). Columbus, OH: Merrill.

Wang, X., Li, L., & Su, H. (2023). Triangulating multiple data sources to understand student engagement in blended learning environments: A systematic review. *Computers & Education*, *201*, 104827.

Xie, K., Hensley, L. C., Law, V., & Sun, Z. (2019). Self-regulation as a function of perceived learner-instructor relationship and academic self-efficacy in online learning. *Journal of Computing in Higher Education*, *31*(2), 293–316.

Zhao, Y., Wang, N., Li, Y., & Zhou, Y. (2021). A literature review of blended learning: Advances and challenges. *International Journal of Educational Technology in Higher Education*, *18*(1), 60.