

Instructor-student interaction in online higher education: Comparing synchronous, asynchronous, and blended interaction at Can Tho University

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Abstract:

This study examines the current state of instructor-student interaction in online learning at Can Tho University, a public comprehensive university in southern Vietnam, with a focus on three forms of interaction: synchronous interaction, asynchronous interaction, and blended interaction. The study adopts a quantitative, cross-sectional, descriptive-comparative survey design. Data were collected from 636 students and 57 instructors with prior experience in online or blended teaching and learning at Can Tho University. The analytical methods employed include descriptive statistics, independent-samples t-tests, one-way analysis of variance (ANOVA), and multiple linear regression analysis. Descriptive statistics were reported for both groups, whereas all inferential analyses were conducted using the student sample. The findings indicate that the level of interaction in online learning ranges from moderate to relatively high, with synchronous and blended interactions being evaluated more positively than asynchronous interaction. Gender does not result in statistically significant differences in interaction levels; however, academic performance and familiarity with online learning have significant effects on all three forms of interaction. Regression analysis further reveals that only synchronous interaction shows a statistically significant association with students' academic performance. This study provides empirical evidence within the context of Vietnamese higher education and offers practical implications for improving the effectiveness of online teaching and learning organisation.

Keywords: asynchronous interaction, blended interaction, higher education, online learning interaction, synchronous interaction.

Classification numbers: 1.3, 3.2, 3.3

1. Introduction

The development of digital technologies and the ongoing digital transformation in higher education have accelerated the widespread implementation of online and blended learning formats. In this context, pedagogical interaction between instructors and students is widely regarded as a core factor determining learning quality, student engagement, and learning outcomes in online environments [1, 2]. A growing body of research indicates that interaction plays a role no less important than that of instructional content or technological platforms, while also contributing to the establishment of instructional presence and students' perceived academic support in online learning contexts [3-6].

In online higher education, instructor-student interaction is commonly classified into three main formats: synchronous interaction, asynchronous interaction, and

blended interaction. Beyond student engagement and satisfaction, instructional interaction has been increasingly examined as a factor associated with academic performance in online higher education. Synchronous interaction, facilitated through real-time online meeting tools, enhances social presence, enables timely feedback, and supports active student participation [1, 7]. Empirical studies have shown that this form of interaction is positively associated with student engagement and learning outcomes, particularly in courses that require frequent communication and discussion [8]. By contrast, asynchronous interaction, implemented through learning management systems (LMS), discussion forums, email, and digital learning materials, offers greater flexibility and supports the development of students' self-regulated learning skills [2, 9]. However, the effectiveness of asynchronous interaction depends substantially on the level of instructional guidance and instructor feedback;

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when pedagogical structure and instructional presence are insufficient, student engagement may decline [3, 4, 10]. Consequently, recent studies have advocated blended interaction models that intentionally integrate synchronous and asynchronous activities to optimise learning experiences and support student engagement in higher education [11-13].

Prior research in Vietnamese higher education contexts indicates that lecturers' conceptions of online teaching are strongly shaped by established pedagogical orientations and sociocultural influences. U.N.T. Nguyen, et al. (2024) [14] demonstrated that, even in distance education courses, Vietnamese university lecturers tend to conceptualise online teaching through a teacher-centred lens, emphasising structured knowledge transmission, content control, and the guiding role of instructors - patterns partly rooted in Confucian heritage educational traditions. Complementing these findings, empirical evidence from Vietnamese tertiary online programmes suggests that while teaching presence has become increasingly emphasised to support student engagement and interaction, instructional practices often remain instructor-centric, reflecting both continuity and gradual pedagogical adaptation within the local educational context [15, 16]. Taken together, these contextual characteristics suggest that instructor-student interaction in Vietnamese online learning environments may operate differently from interaction patterns commonly reported in Western higher education systems.

In addition to international research, empirical evidence from Vietnam also underscores the important role of interaction in online learning. L.N. Hai, et al. (2021) [17] found that students' satisfaction with online learning was significantly influenced by the level of instructor-student interaction, particularly through direct communication and two-way feedback. Nevertheless, existing domestic studies have primarily focused on student satisfaction or learning experiences [18-19], while research simultaneously examining multiple interaction formats and comparing instructors' and students' perceptions remains limited. More broadly, despite the rapid expansion of research of online and blended learning interaction, existing empirical evidence remains disproportionately concentrated in Western and developed higher education contexts. Recent review and large-scale empirical studies indicate that much of the literature on online learning interaction, instructional presence, and learning outcomes has been conducted in North America, Europe, and other developed regions, while empirical research focusing on Southeast Asian and Vietnamese higher education contexts remains comparatively limited [4, 20]. This imbalance underscores

the need for context-sensitive investigations that examine instructor-student interaction within underrepresented educational systems such as Vietnam.

In Vietnam, the COVID-19 pandemic accelerated the adoption of digital pedagogies across higher education institutions, compelling universities to rapidly implement online and blended learning models to ensure instructional continuity. Evidence from teacher education programmes indicates that this transition not only exposed challenges related to pedagogical adaptation and digital competencies among educators and learners, but also reinforced the necessity of sustaining online and blended learning approaches beyond the pandemic period [21]. As a result, understanding how different forms of instructor-student interaction function in online and blended learning environments has become a pressing practical concern for Vietnamese universities in the post-COVID-19 era. Despite the growing literature on interaction in online learning, several notable research gaps remain. *First*, most existing studies have been conducted in developed countries, whereas empirical evidence from higher education institutions in Vietnam is still scarce. *Second*, relatively few studies have simultaneously examined differences in perceptions of interaction between instructors and students. *Third*, the role of learner characteristics such as academic performance and familiarity with online learning in shaping instructor-student interaction has not yet been sufficiently clarified within a single research framework. Based on these identified gaps, the present study addresses the following research questions:

RQ1. Are there differences between instructors' and students' perceptions of synchronous, asynchronous, and blended interaction in online learning?

RQ2. Which student characteristics (gender, academic performance, and familiarity with online learning) influence the level of instructor-student interaction in online learning?

RQ3. How are synchronous, asynchronous, and blended interaction associated with students' academic performance?

Rather than seeking to produce entirely new theoretical claims, this study contributes context-sensitive empirical evidence from a Vietnamese higher education setting, where cultural expectations, institutional conditions, and pedagogical traditions may shape instructor-student interaction differently from patterns commonly reported in Western literature. By simultaneously comparing synchronous, asynchronous, and blended interaction modes and incorporating both student and instructor perspectives within a single institutional context, this

study offers nuanced insights into how established interaction mechanisms operate in an underrepresented educational environment.

2. Literature review

In online learning research, instructional interaction is commonly examined through participants' perceptions, as these perceptions shape engagement, participation, and learning behaviours. Instructor-student interaction is a key factor determining learning quality, student satisfaction, and academic outcomes in online and blended learning environments in higher education [2, 22]. Three main forms of interaction are commonly identified: synchronous interaction, asynchronous interaction, and blended interaction, each of which has distinct characteristics, roles, and implications for students' learning experiences [1, 12].

To provide stronger conceptual grounding for examining instructor-student interaction in online learning, this study draws on established interaction-oriented theoretical frameworks. Moore's Transactional Distance Theory posits that the psychological and communicative distance between instructors and learners is shaped by the interplay of dialogue, structure, and learner autonomy, with higher levels of dialogue reducing transactional distance and supporting learning outcomes [23]. From this perspective, synchronous interaction characterised by real-time communication and immediate feedback can reduce transactional distance more effectively than asynchronous formats, particularly in structured educational settings.

In addition, the Community of Inquiry (CoI) framework conceptualises effective online learning as the intersection of teaching presence, social presence, and cognitive presence [24]. Subsequent empirical research has demonstrated that teaching presence plays a critical role in facilitating meaningful interaction and sustaining student engagement in online learning environments [25]. In particular, instructional approaches that enable immediacy, visibility, and interactive dialogue features commonly associated with synchronous interaction have been found to support the development of teaching and social presence, thereby fostering conditions conducive to deeper cognitive engagement.

2.1. Synchronous interaction

Synchronous interaction occurs in real time through platforms such as Zoom and Google Meet, enabling direct communication and immediate feedback between instructors and students. This form of interaction enhances social presence, learning motivation, psychological support, and the creation of a positive learning environment [1, 26]. However, synchronous interaction

is highly dependent on technological conditions and scheduling constraints, which may pose challenges for some students [27].

2.2. Asynchronous interaction

Asynchronous interaction takes place through discussion forums, LMS, email, and recorded video lectures, allowing students to engage in learning activities, exchange ideas, and receive feedback beyond scheduled class time. This form of interaction increases flexibility, supports self-directed learning, and is suitable for diverse student populations [2, 28]. Nevertheless, asynchronous interaction may reduce students' sense of connectedness if it is not complemented by additional interactive activities [29].

Recent studies highlight that the effectiveness of asynchronous online learning depends strongly on the pedagogical design of learning activities and the degree of instructional guidance provided to students. Research on the Southern Cross Model in Australia indicates that structured online learning modules incorporating interactivity, media richness, and constructive alignment can significantly enhance student engagement and academic performance [30]. Similarly, curriculum innovations emphasising guided learning pathways and active learning principles have been shown to support deeper engagement and the development of communities of inquiry in online higher education environments [31]. These findings suggest that asynchronous interaction can play an important role in supporting learning effectiveness when it is supported by clear instructional structure and responsive teaching practices.

2.3. Blended interaction

Blended interaction refers to the purposeful integration of synchronous and asynchronous interaction, leveraging the strengths of both formats to optimise learning effectiveness. This approach facilitates knowledge acquisition, sustains learning motivation, and supports the development of self-regulated learning and collaborative skills among students [11, 12, 32]. Previous studies emphasise the importance of clear course design, diverse learning activities, timely feedback, and the establishment of trusting instructor-student relationships in ensuring the effectiveness of blended interaction [2, 13].

In summary, the flexible integration of synchronous, asynchronous, and blended interaction, together with appropriate pedagogical design, constitutes a critical foundation for enhancing the quality and effectiveness of online learning in higher education institutions [1, 2, 12].

Beyond Western contexts, empirical studies from other Asian and developing higher education environments have also highlighted distinctive patterns

of online interaction and engagement. For example, a case study in an Indonesian university found that university students demonstrated higher engagement levels in synchronous online activities, as these settings enabled real-time interaction with instructors and peers, while asynchronous activities were still valuable but often required structured facilitation to support engagement [33]. Similarly, research with Chinese tertiary English as a foreign language (EFL) learners indicates that classroom interaction including learner-instructor and learner-content interaction is positively associated with students' perceptions of online learning quality and satisfaction, underscoring the role of interaction dynamics in shaping online learning experiences in non-Western contexts [34]. These findings suggest that culturally embedded expectations regarding instructional interaction and engagement may influence the relative effectiveness of different interaction modes, highlighting the need for context-sensitive empirical investigations in underrepresented higher education systems.

Although synchronous, asynchronous, and blended interaction have been widely examined in prior studies, existing research has often focused on one interaction mode in isolation. Comparatively fewer studies have examined these interaction modes within a single empirical framework, particularly in higher education contexts in developing countries. This suggests a need for comparative research that systematically examines similarities and differences across interaction modes.

3. Methods

This study is situated as an empirical case study conducted at a large public university in Vietnam, aiming to provide context-specific evidence on instructor-student interaction in online higher education.

3.1. Research design

This study employed a quantitative, cross-sectional, descriptive-comparative survey design. This design was appropriate for examining the level of instructor-student interaction in online learning, analysing differences according to learner characteristics, and comparing perceptions between instructors and students. The survey was conducted from September to November 2025, involving 636 students and 57 instructors who had prior experience in online or blended teaching and learning at Can Tho University.

3.2. Participants and sampling

The study participants included students and instructors with prior experience in online or blended teaching and learning at Can Tho University. A convenience sampling method was used, which was suitable given the research context. A total of 636 valid student questionnaires

(Table 1) and 57 instructor questionnaires were included in the analysis. The student sample comprised undergraduate students from various academic disciplines, while data from instructors were collected to facilitate comparisons of perceptions regarding online interaction between the two groups. The sample size met the requirements for the statistical analyses employed in this study.

Table 1. Demographic characteristics of the respondents (students).

Survey information	Content	Quantity	Percentage (%)
Gender	Male	314	49.4
	Female	322	50.6
Academic performance	Low	2	0.3
	Average	30	4.7
	Good	169	26.6
	Very good	297	46.7
	Excellent	138	21.7
Familiarity with online learning	Low	21	3.3
	Moderate	318	50.0
	High	297	46.7

Source: Data collected by the authors.

Data were collected through an online questionnaire administered via Google Forms. The survey link was distributed to students and instructors who were accessible through institutional communication channels and had experience with online or blended courses. Participation was voluntary, and all valid responses received during the data collection period were included in the analysis. Due to the online and voluntary nature of the survey, the exact number of invitations distributed could not be determined; therefore, the study focused on maximising response completeness rather than calculating a response rate.

Although convenience sampling may limit the generalisability of the findings, this approach is widely used in educational research, particularly in studies of online learning contexts where participant accessibility and voluntary participation are essential considerations.

The study was conducted at Can Tho University, a large public university in the Mekong Delta region of Vietnam. As the data were collected from a single higher education institution, the findings should be interpreted with caution, and their generalisability to other institutional or national contexts may be limited.

3.3. Data collection instrument

Data were collected using a structured questionnaire consisting of two main sections. The first section gathered demographic and academic information, including gender, academic performance, and familiarity

with online learning. Students' academic performance was measured using self-reported cumulative grade point average (GPA) and subsequently categorised into five levels (low, average, good, very good, and excellent) for analytical purposes. This approach was adopted to facilitate group comparisons in the descriptive and comparative analyses, while the same variable was treated as a continuous outcome in the regression analysis examining the relationship between interaction types and academic performance.

The second section measured instructor-student interaction in online learning across three dimensions: synchronous interaction (3 observed items), asynchronous interaction (4 observed items), and blended interaction (3 observed items). All items were measured using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Mean scores of the observed items were calculated to represent each interaction dimension in subsequent analyses.

The measurement items were developed based on established classifications of instructor-student interaction in online learning, distinguishing synchronous, asynchronous, and blended interaction as theoretically grounded and conceptually distinct dimensions. Content validity was ensured through careful adaptation of items from prior empirical studies and alignment with the research objectives. Given the clear theoretical foundations and the descriptive-comparative nature of the study, construct validity was addressed through internal consistency reliability rather than exploratory or confirmatory factor analysis. Cronbach's alpha coefficients for all interaction dimensions exceeded the acceptable threshold of 0.70, indicating satisfactory internal consistency.

3.4. Data analysis

Data were processed and analysed using SPSS software. Descriptive statistics were used to describe levels of synchronous, asynchronous, and blended interaction. Independent-samples t-tests and one-way analysis of variance (ANOVA) were conducted to examine differences in interaction levels according to learner characteristics. Multiple linear regression analysis was performed to examine the relationships between different forms of interaction and students' academic performance. The reliability of the measurement scales was assessed using Cronbach's alpha prior to conducting subsequent statistical analyses. The level of statistical significance was set at $p < 0.05$.

Descriptive statistics were reported for both instructors and students to present their respective perceptions of instructor-student interaction. However, all inferential analyses, including independent-samples t-tests, one-way ANOVA, repeated-measures ANOVA, and multiple

linear regression, were conducted using only the student dataset ($n=636$), as the study aimed to examine factors associated with students' academic performance.

3.5. Ethical considerations

The study adhered to ethical principles in social science research. Participants were informed of the research purpose and their right to refuse participation or withdraw at any time. All data were collected and analysed anonymously and were used solely for research purposes.

4. Results

In Table 2, the descriptive statistics indicate that the level of interaction between instructors and students in online learning ranged from moderate to high across all three interaction types. Cronbach's alpha values ranged from 0.820 to 0.925, indicating good to excellent internal consistency for all interaction scales.

Regarding synchronous interaction, students reported high levels of participation in live online sessions ($M=4.11$) and perceived timely instructor feedback during these sessions ($M=3.96$), whereas their proactive engagement in asking questions or sharing opinions remained at a moderate level ($M=3.40$). Instructors rated the timeliness of direct feedback during synchronous sessions more highly than students ($M=4.16$ compared to $M=3.96$).

For asynchronous interaction, both groups acknowledged the positive role of digital learning materials and instructor feedback delivered via the LMS ($M>3.90$). However, active engagement in discussion forums was reported to be relatively limited.

With respect to blended interaction, both students and instructors expressed positive perceptions of the effectiveness of integrating synchronous and asynchronous activities, with mean values ranging from 3.77 to 4.02.

Overall, the descriptive results suggest that instructor-student interaction in online learning at Can Tho University was perceived as moderate to high across all three interaction types. Synchronous and blended interactions were evaluated more positively than asynchronous interaction. Although there was a general convergence in perceptions between instructors and students, certain differences remained, particularly with regard to students' proactive participation. These findings provide a foundation for the comparative and regression analyses presented in the subsequent sections.

The descriptive statistics presented below include responses from both instructors and students. However, all subsequent inferential analyses reported in Tables 3-5 were conducted using the student sample ($n=636$) only.

Table 2. Descriptive statistics of instructor-student interaction by interaction type and participant group.

Item	Description	Students		Instructors		Cronbach's alpha
		Mean	Std. deviation	Mean	Std. deviation	
Synchronous interaction						
SI1	Students regularly attend live online classes (e.g., Zoom, Google Meet).	4.11	0.993	3.84	0.922	0.820
SI2	Students actively ask questions or share opinions during live online classes.	3.40	1.023	3.35	1.142	
SI3	The instructor provides direct and timely feedback during live online classes.	3.96	0.979	4.16	0.819	
Asynchronous interaction						
AI1	Students frequently communicate with instructors through discussion forums or the LMS.	3.36	1.062	3.32	1.055	0.889
AI2	Instructors upload videos, lectures, and materials that support effective self-study.	3.94	0.972	3.98	0.876	
AI3	Students receive feedback from instructors via email or the LMS.	3.95	0.986	3.91	0.872	
AI4	Students actively review recorded lectures or participate in forum discussions after class.	3.73	0.992	3.54	1.103	
Blended interaction						
BI1	Instructors effectively integrate live online classes (e.g., Zoom) with self-study activities on the LMS.	3.82	0.970	3.93	0.821	0.925
BI2	Students feel that blended learning helps them better understand the content and maintain learning motivation.	3.82	0.974	3.68	0.948	
BI3	Students can interact with instructors both during online classes and outside class via the LMS or email.	3.77	1.019	4.02	0.813	

Source: Data collected by the authors. Note: Synchronous interaction (SI); Asynchronous interaction (AI); Blended interaction (BI); Learning management system (LMS).

Table 3. Differences in synchronous, asynchronous, and blended interaction by student characteristics.

Independent variable	Dependent variable	Sig. (p-value)	Significant group differences (post-hoc)
Gender	SI	0.126	—
	AI	0.398	—
	BI	0.384	—
Academic performance (Low - Average - Good - Very good - Excellent)	SI	0.000	Excellent>Average, Good, Very good
	AI	0.000	Excellent>Low, Average, Good
	BI	0.001	Excellent>Average, Good; Very good>lower-performing groups (LSD)
Familiarity with online learning (Low - Moderate - High)	SI	0.000	High>Moderate>Low
	AI	0.000	High>Moderate>Low
	BI	0.000	High>Moderate>Low

Source: Data collected by the authors. Note: Synchronous interaction (SI); Asynchronous interaction (AI); Blended interaction (BI); Least significant difference (LSD).

The results in Table 3 indicate that gender did not produce statistically significant differences in synchronous, asynchronous, or blended instructor-student interaction in online learning. In contrast, academic performance and familiarity with online learning had significant effects on

all three interaction types. Students with higher academic achievement and greater familiarity with online learning consistently reported higher levels of interaction than their counterparts. These findings provide an empirical basis for the subsequent regression analyses.

Table 4. Comparison of students' perceptions across three interaction types

Interaction type	Mean	SD
Synchronous interaction (SI)	3.822	0.856
Asynchronous interaction (AI)	3.745	0.870
Blended interaction (BI)	3.804	0.921

Repeated-measures ANOVA (Greenhouse-Geisser): $F(1.91, 1212.73)=10.32$, $p<0.001$, partial $\eta^2=0.016$. Bonferroni post hoc: SI>AI ($p<0.001$); BI>AI ($p=0.001$); SI=BI ($p=1.000$).

Before examining the predictive effects of the three interaction types on students' academic performance, a repeated-measures ANOVA was conducted to compare students' perceptions of synchronous interaction (SI), asynchronous interaction (AI), and blended interaction (BI). As presented in Table 4, Mauchly's test indicated that the assumption of sphericity was violated ($p<0.001$); therefore, the Greenhouse-Geisser correction was applied. The analysis revealed a statistically significant

difference among the three interaction types, $F(1.91, 1212.73)=10.32$, $p<0.001$, partial $\eta^2=0.016$. Bonferroni-adjusted pairwise comparisons indicated that synchronous interaction ($M=3.82$, $SD=0.86$) and blended interaction ($M=3.80$, $SD=0.92$) were both rated significantly higher than asynchronous interaction ($M=3.75$, $SD=0.87$) ($p<0.001$ and $p=0.001$, respectively), whereas no statistically significant difference was found between synchronous and blended interaction ($p=1.000$). These findings suggest that students perceived synchronous and blended interaction slightly more positively than asynchronous interaction, providing a descriptive basis for the subsequent regression analysis presented in Table 5.

Table 5. Multiple linear regression results predicting students' academic performance.

Model	Unstandardised coefficients		Standardised coefficients	t	Sig.	
	B	Std. Error	Beta			
1	(Constant)	3.120	0.149		20.907	0.000
	SI	0.179	0.082	0.186	2.167	0.031
	AI	0.021	0.095	0.022	0.217	0.828
	BI	-0.009	0.081	-0.010	-0.106	0.916

Source: Data collected by the authors. Note: Synchronous interaction (SI); Asynchronous interaction (AI); Blended interaction (BI).

The results in Table 5 of the multiple linear regression analysis indicate that the research model is statistically significant overall ($F(3, 632)=8.51$, $p<0.001$), suggesting that only synchronous interaction is significantly associated with students' academic performance. The model explains approximately 3.9% of the variance in academic performance ($R^2=0.039$).

At the predictor level, SI shows a positive and statistically significant association with academic performance ($\beta=0.186$, $p=0.031$). By contrast, AI ($\beta=0.022$, $p=0.828$) and BI ($\beta=-0.010$, $p=0.916$) do not demonstrate statistically significant associations in the regression model.

Overall, the findings indicate that among the three interaction types examined, only synchronous interaction serves as a significant predictor of students' academic performance. These results provide an empirical basis for the subsequent discussion.

5. Discussion

The descriptive results indicate that the level of instructor-student interaction in online learning at Can Tho University ranges from moderate to moderately high across the three interaction types: synchronous, asynchronous, and blended interaction. Among these, synchronous and blended interaction were perceived

more positively by both students and lecturers than asynchronous interaction. This finding is consistent with previous studies emphasising the importance of real-time interaction in enhancing teaching presence, perceived instructional support, and student engagement in online learning environments [1, 7]. In particular, in the Vietnamese higher education context, the stronger perception of synchronous and blended interaction may also be explained by prevailing pedagogical traditions that emphasise instructor guidance, real-time explanation, and direct academic support. Specifically, prior research indicates that online teaching practices in Vietnam continue to reflect instructor-centred orientations shaped by sociocultural expectations and institutional norms, which may heighten students' reliance on synchronous interaction for learning clarification and engagement [14, 20].

Notably, while lecturers tended to rate the organisation and responsiveness of interaction activities relatively highly, students reported lower levels of active participation, particularly in synchronous interaction. This discrepancy reflects a perception gap commonly reported in online learning research, where instructors evaluate interaction based on instructional design, whereas students' perceptions are more strongly shaped by their actual learning experiences [4, 7, 17]. More broadly, such perception gaps have been widely documented in online and emergency remote teaching contexts, where instructors often evaluate interaction based on instructional planning and facilitation efforts, while students' perceptions are more closely linked to their actual participation opportunities, feedback experiences, and cognitive engagement during learning activities [4, 5, 33]. Taken together, this divergence highlights the importance of examining both instructor and student perspectives when evaluating interaction quality in online learning environments.

Turning to learner characteristics, the comparative analysis indicates that gender does not produce statistically significant differences across the three interaction types. This finding suggests that, in the context of online learning at Can Tho University, instructor-student interaction is not substantially influenced by gender-related factors, aligning with trends reported in recent higher education studies [12]. By contrast, academic performance and familiarity with online learning have significant effects on students' interaction levels. Students with higher academic achievement and greater familiarity with online learning consistently demonstrate higher levels of interaction across synchronous, asynchronous, and blended formats. These findings reinforce existing arguments that academic competence, self-regulation,

and technological experience are critical factors in fostering engagement and interaction in online learning environments [2, 29]. The multiple linear regression analysis reveals that among the three interaction types examined, only synchronous interaction shows a positive and statistically significant association with students' academic performance. This result highlights the central role of real-time interaction, which enables timely feedback, cognitive support, and sustained learning motivation. Consistent with this interpretation, the finding is consistent with previous studies, particularly in educational contexts characterised by instructor-centred approaches and an emphasis on direct interaction, such as in Vietnam [1, 26].

The findings should also be interpreted within the regional context of the Mekong Delta, where Can Tho University serves as the largest higher education institution for students from many surrounding provinces. Although digital transformation has accelerated across Vietnamese higher education, disparities in internet infrastructure, device accessibility, and digital competencies remain evident among students from rural and remote areas. Such contextual factors may reduce the effectiveness of synchronous interaction because unstable internet connections, limited bandwidth, and varying levels of digital literacy can restrict students' ability to participate actively in real-time online sessions. Consequently, strengthening regional digital infrastructure and improving students' digital competencies should accompany pedagogical improvements in order to maximise the effectiveness of online interaction.

However, although the regression model was statistically significant, its explanatory power was relatively modest ($R^2=0.039$), indicating that instructor-student interaction accounted for only a limited proportion of the variance in academic performance. This finding suggests that academic achievement is a multidimensional outcome influenced by numerous factors beyond interaction alone, including learning motivation, self-regulated learning, prior academic ability, assessment practices, socioeconomic background, and digital learning competencies. Therefore, the present findings should be interpreted as evidence of a statistically significant but practically modest contribution of synchronous interaction rather than a strong predictor of academic performance.

This finding aligns with prior research indicating that academic outcomes in online and blended learning are influenced by a broader constellation of factors, including self-regulated learning strategies, learning motivation, prior academic ability, instructional design quality, and assessment practices [2, 7, 9]. Therefore, the present

findings should be interpreted as highlighting the contributory - rather than determinant - role of interaction in academic performance.

In this context, although asynchronous and blended interaction do not demonstrate significant predictive effects in the regression model, the descriptive and comparative results suggest that these interaction types still play an important supportive role by facilitating flexible learning opportunities and maintaining student engagement. From a pedagogical perspective, this indicates that the effectiveness of asynchronous and blended interaction may depend more heavily on pedagogical design and the extent to which these activities are meaningfully integrated into course assessment. Previous studies suggest that asynchronous and blended interaction modes primarily support learning indirectly by fostering flexibility, sustained engagement, and opportunities for reflection, rather than producing immediate gains in academic performance as measured by GPA [11, 13]. Therefore, their effectiveness is highly contingent on pedagogical design, assessment alignment, and the extent of instructional scaffolding provided by instructors.

Based on these findings, improving the effectiveness of online learning at Can Tho University should not rely solely on increasing synchronous interaction. Instead, greater attention should be given to strengthening the pedagogical design of asynchronous learning activities, particularly through timely instructor feedback and clearer instructional guidance that help students navigate the learning process [31, 32]. At the same time, the purposeful design of asynchronous and blended activities, accompanied by timely feedback and clear pedagogical structure, may contribute to improving student participation and learning quality in online and blended learning models. Overall, these findings underscore the importance of aligning interaction design with students' academic readiness and online learning experience to enhance the effectiveness of online and blended instruction.

Finally, consistent with prior research on blended and online learning design, these findings suggest that institutions should prioritise well-structured synchronous interaction while simultaneously enhancing the pedagogical integration of asynchronous and blended activities through clear guidance, timely feedback, and alignment with assessment strategies [12, 30].

6. Conclusions

This study examined the levels and roles of instructor-student interaction in online learning at Can Tho University, focusing on three interaction types: synchronous, asynchronous, and blended interaction.

The findings indicate that overall interaction levels are moderate to moderately high, with synchronous and blended interaction being perceived more positively than asynchronous interaction.

Comparative analyses reveal that gender does not produce significant differences in interaction levels, whereas academic performance and familiarity with online learning significantly influence all three interaction types. In particular, students with higher academic achievement and greater experience with online learning consistently report higher levels of interaction.

The regression results further demonstrate that among the interaction types examined, only synchronous interaction is significantly associated with students' academic performance. This finding highlights the central role of real-time instructional interaction, timely feedback, and teaching presence in supporting learning outcomes in online higher education.

From a practical perspective, the findings suggest that improving the effectiveness of online learning at Can Tho University requires not only maintaining meaningful synchronous interaction but also strengthening the pedagogical design of asynchronous learning environments. In particular, providing timely feedback and clearer instructional guidance may help enhance student engagement and learning effectiveness in asynchronous settings. Academically, this study contributes empirical evidence from the Vietnamese higher education context, thereby extending existing discussions on effective pedagogical interaction in online and blended learning environments.

7. Limitations

Despite its contributions, this study has several limitations that should be acknowledged. *First*, the cross-sectional survey design limits the ability to draw causal inferences between instructor-student interaction and students' academic outcomes. *Second*, the data were collected from a single public university in Vietnam, which may constrain the generalisability of the findings to other institutional or cultural contexts. *Third*, while lecturers' responses were included to provide descriptive and contextual insights, the relatively small number of lecturer participants precluded more advanced inferential analyses for this group.

In addition, this study adopted a purely quantitative research design and did not incorporate qualitative data, such as open-ended responses or interviews, which may have provided richer contextual insights into students' and instructors' experiences particularly regarding why synchronous interaction was perceived as more effective in this setting. Future studies employing mixed-methods

or qualitative approaches are therefore recommended to deepen understanding of the contextual and pedagogical mechanisms underlying instructor-student interaction in Vietnamese higher education.

Another limitation concerns the use of self-reported GPA, which is common in educational research where access to official academic records is restricted, and prior studies have shown acceptable consistency between self-reported and actual academic performance when anonymity is ensured. Nevertheless, the authors acknowledge that self-reported academic performance may be subject to reporting bias, which is addressed as a limitation of the study.

Finally, the model explained a modest proportion of variance in students' academic performance, suggesting that additional factors such as learning motivation, self-regulation, instructional design quality, or assessment practices may also play important roles and should be examined in future research.

CRediT author statement

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COMPETING INTERESTS

The authors declare that there is no conflict of interest regarding the publication of this article.

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