The Impact of Online Interaction on College Students' Perceived Deeper Learning

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Abstract

This study focuses on the intrinsic relationship between the online interaction and college students' perceived deeper learning. Taking the online course "Information Technology Foundation" as an example, the course based on the four-dimensional interaction framework of "teacher-student, student-student, student-content, and student-platform interactions" was implemented for one semester. The questionnaire survey revealed that the college students' deeper learning perception had significantly improved, and all four dimensions of online interaction had significant impact on the perceived deeper learning. These findings indicate that the improvement of online learning quality should not be limited to merely digitizing the content, but rather should involve the establishment of a multi-dimensional interactive learning ecosystem. This provides significant insights for optimizing the instructional design and practical innovation of online courses in higher education.

Keywords: Deeper Learning; Online Interaction; College Students; Course Design

1. Introduction

The rapid advancement of information technology has significantly accelerated the digital transformation of higher education (Alenezi, 2023). The emergence of Massive Open Online Courses, Small Private Online Courses, and a variety of intelligent learning platforms has shifted online learning from a supplementary model to an integral component of higher education (Rof et al., 2022). However, compared to traditional face-to-face instruction, the online environment inherently faces challenges such as temporal and spatial separation between teachers and students, as well as limited opportunities for immediate feedback (Greenhow et al., 2022). These limitations have prompted growing concerns among educational researchers regarding learning quality, particularly whether online environments can transcend surface-level knowledge transmission and effectively foster deeper learning among college students.

Deeper learning emphasizes the active knowledge construction by learners, enabling them to flexibly apply acquired knowledge to address complex, real-world problems (Shen & Chang, 2023). However, traditional online learning models that remain confined to one-way content delivery are prone to fostering passive reception and rote memorization, leading to superficial engagement. Online interaction is widely recognized as a critical enabler in overcoming the limitations of superficial learning in digital environments (Otto & Raturi, 2024). High-quality interactions not only mitigate the challenges posed by physical separation but also stimulate cognitive dissonance, support collaborative knowledge construction, and facilitate timely feedback and instructional support—essential components for fostering deeper learning (Zhou et al., 2024).

Although existing studies broadly acknowledge the significance of online interaction, most treat interaction as a unified construct without examining the distinct effects of various interaction types on deeper learning. Therefore, this study focuses on the following two questions:

(1) Has the college students' perceived deeper learning significantly improved after they have participated in the online interactive course?

(2) How do different dimensions of online interaction affect the college students' perceived deeper learning?

2. Literature review

2.1. Deeper learning in online learning environments

Deeper learning emphasizes a critical understanding of knowledge, deep communication, and the capacity to transfer learning to real-world contexts (Mthethwa-Kunene et al., 2022), which aligns closely with the core competencies promoted in contemporary higher education. The online learning environment presents both opportunities and challenges for fostering deeper learning. On one hand, the vast amount of resources on the internet enables students to explore issues from diverse perspectives, thereby supporting knowledge integration and critical thinking (Almulla & Al-Rahmi, 2023). Technological affordances such as asynchronous discussion forums provide learners with increased time for reflection, facilitating more thoughtful, coherent expression and argumentation, which enhances deeper cognition. On the other hand, the overwhelming volume of information may lead to cognitive overload, and the inherent entertainment and communication features of online environments can easily distract learners, thereby impeding sustained, focused, and deeper cognitive engagement (Wang, 2022). Furthermore, the lack of social presence typically associated with face-to-face interaction may result in feelings of isolation among students, diminish their motivation to engage in in-depth discussions and collaborative activities, and hinder the social knowledge construction.

The depth of online learning is not inherently enabled by technology, but rather depends on the instructional strategies. Lavi and Marti (2023) indicated that when teachers acted as expert facilitators rather than knowledge providers, and adopted case-based learning methods to contextualize learning of discipline or practice-specific knowledge, it could cultivate the innovation and critical thinking skills of undergraduate engineering students. Wang et al. (2022) pointed out that adding icons to students' virtual avatars to indicate their willingness to establish connections with others could help them identify potential social partners and facilitate communication and collaboration among individuals. Archambault et al. (2022) recognized the significance of the relationship between teachers and students in the learning process, an affectionate relationship could provide students with a stronger sense of belonging and higher levels of participation, thereby promoting academic success. Therefore, the quality of online learning mainly depends on its instructional design and the effectiveness of the interactions it supports.

2.2. Online interaction

The core of online learning rests upon interaction, which plays a pivotal role in overcoming spatial and temporal separation, building learning communities, and achieving learning goals (Wu et al., 2022). It is not merely a channel for information exchange but also the cornerstone for social knowledge construction and the occurrence of deeper learning. Online interaction primarily includes teacher-student, student-student, student-content, and student-platform interactions (Hillman et al., 1994; Moore, 1989). Teacher-student interaction entails bidirectional communication between teachers and learners, encompassing instructional delivery, content explanation, feedback provision, question resolution, and students' proactive engagement in seeking academic guidance (Jackson, 2024). Student-student interaction involves synchronous or asynchronous communication and collaboration among learners, which is manifested in forms such as group discussions, peer assessments, collaborative project completion, and knowledge sharing (Li & Lin, 2025). Student-content interaction efers to the cognitive engagement between learners and learning materials, spanning from basic activities like reading and watching videos to advanced practices such as critical thinking, content reorganization, and personalized knowledge construction (Al Mamun & Lawrie, 2024). Student-platform interaction pertains to learners' operational engagement with the learning platform's interface to access resources and complete learning tasks

(Wang & Perey, 2024). This study investigates the impact of online interaction on deeper learning from these four dimensions.

Online interaction fosters a diverse, real-time, and structured social learning environment. Through discussion, collaboration, and feedback, students disrupt their initial cognitive equilibrium and are thereby motivated to engage in deeper inquiry (Li & Lin, 2025. Al Mamun and Lawrie (2024) found that the scaffolding elements embedded in the learning module could enhance the learner-content interaction, thereby generating higher-order cognition and stimulating the learners' critical thinking. Almulla (2023) demonstrated that student-student interaction, particularly collaboration and discussion around complex tasks, might help students solve problems and improve their grades. The exchange and confrontation of diverse perspectives among peers could significantly challenge and expand individual cognitive frameworks. Teacher-student interaction served as a key determinant of learning quality and learner motivation. Price et al. (2021) underscored that instructors were no longer positioned solely as authoritative sources of knowledge, but rather as facilitators, guides, and providers of formative feedback. Timely and constructive feedback had been shown to substantially enhance students' learning effectiveness and satisfaction. Furthermore, student-platform interaction formed the operational foundation for other forms of interaction. Bhambri and Rani (2025) explored the significance of human-computer interaction in meeting the learners' needs , and emphasized the role of the interface in constructing educational experiences. Seamless interaction with the learning platform optimized the learning experience, whereas poor interface design introduced extraneous cognitive load, thereby impeding and undermining engagement in other interactive processes.

3. Research design and methodology

3.1. Course design

This study takes the online course "Information Technology Foundation" as an example, and conducts instructional design from four dimensions: teacher-student interaction, student-student interaction, student-content interaction, and student-platform interaction, with the aim of enhancing college students' deeper learning competency.

3.1.1. Teacher-student interaction design

In the design of teacher-student interaction activities for the online course "Information Technology Foundation", the teacher should move beyond traditional one-way instructional model and adopt the role of a guiding coach. Specifically, the teacher-student interaction activities should span the entire learning process: pre-class guidance, in-class dialogue, and post-class reflection. Prior to class, the teacher analyzed data from the learning platform to identify college students' cognitive gaps and subsequently designed targeted preparatory tasks and thought-provoking questions. During synchronous video sessions, the teacher facilitated collaborative, problem-based activities, such as guiding students in screen sharing, jointly debugging solutions to individual challenges, and posing probing questions throughout the problem-solving process to uncover underlying principles. After class, the teacher provided descriptive feedback and incorporated metacognitive prompts in asynchronous discussion forums and assignment evaluations to support students in summarizing generalizable concepts from specific experiences. The essence of this pedagogical approach lied in transforming each interaction into a cognitive scaffold that enables learners to bridge their zone of proximal development and cultivate expert-like thinking.

3.1.2. Student-student interaction design

The design of student-to-student interaction activities in the online course should not be limited to loose group discussions, but should be constructed through structured collaborative tasks and clear role divisions to form a cognitive community. In complex project-based learning, group members were assigned specific roles with distinct responsibilities. Concurrently, a peer assessment mechanism should be implemented, supported by a transparent evaluation rubric that guides college students in delivering constructive, multidimensional feedback. More significantly, interactions should extend beyond discussion to culminate in the co-creation of cognitive artifacts. For instance, upon project completion, each group was required not only to submit final works but also to collaboratively produce a collective reflection report that examined key technical disputes, resolution processes, and newl understandings. This transformed students from passive task performers into active co-creators of certain works. Through continuous social interaction in the process of viewpoint negotiation and conflict resolution, they ultimately achieved a change in their thinking patterns, which was the core manifestation of deeper learning.

3.1.3. Student-content interaction design

The student-content interaction activities should focus on transforming static content into a series of dynamic and actionable cognitive challenges, enabling college students to actively construct knowledge through in-depth dialogues with the content. The learning materials should not be presented as definitive conclusions, but rather as catalysts for cognitive dissonance and inquiry. For example, in a unit on “Excel Data Analysis”, a semi-open business decision simulation task could be introduced. The students were provided with an original sales dataset intentionally containing redundant, contradictory, and incomplete entries. They must independently explore, evaluate, and integrate diverse techniques—such as data cleaning, pivot tables, and visual charts—to complete the task. This design compeled students to critically analyze, compare, and synthesize information, transforming fragmented technical skills into coherent, problem-solving-oriented analytical competencies and facilitating the deep internalization of knowledge.

3.1.4. Student-platform interaction design

The primary objective of student-platform interaction in online learning environment was to transform the platform from a passive content repository into an intelligent, adaptive, and feedback-rich cognitive partner. The interaction design must transcend basic functional navigation by integrating intelligent technologies that reduced operational load and embed data-driven metacognitive supports directly within the learning environment. For example, the platform may incorporate an intelligent office assistant with natural language processing capabilities. When college students engaged in complex tasks—such as formatting long Word documents—they could pose queries via voice input and received step-by-step guided responses accompanied by real-time simulation demonstrations, rather than static textual instructions. Furthermore, through students’ learning behavior analysis, the platform dynamically constructed personalized cognitive scaffolds and delivered adaptive learning modules tailored to individual progress and performance. The seamless integration of tools and supports aimed to create an immersive learning environment that minimized cognitive disruptions and enabled students’ sustained focus on higher-order cognitive activities, including critical thinking, synthesis, and creative problem solving.

3.2. Participants

The participants of this study were 157 freshmen at a university in southern China, enrolled in the compulsory online course “Information Technology Foundation”, which was taught by the same teacher. She consistently released learning content and supplementary resources on schedule each week, provided online tutoring sessions, facilitated asynchronous discussions, and delivered comprehensive academic, technical, and service-related support to learners in real time through the Learning Platform. Questionnaire links were released at the beginning and the end of the course for conducting the survey. A total of 106 college students successfully completed the pre-test and post-test questionnaires, with an effective recovery rate of 67.52%.

3.3. Instruments

Based on the existing literature (Arbaugh & Rau, 2007; Bray et al., 2008; Cheng, 2013; Kuo et al., 2014), and in accordance with the actual online learning situation, this study developed an online learning questionnaire.

It mainly consisted of an online interaction subscale (12 items) and a deeper learning subscale (3 items). The online interaction subscale included four dimensions: the teacher-student interaction (e.g., The teacher can offer valuable guidance and suggestions for my questions.), the student-student interaction (e.g., I often discuss with other learners online.), the student-content interaction (e.g., Online learning materials can help me better understand the course content.), and the student-platform interaction (e.g., The layout of the learning platform is reasonable and easy to search.), each dimension has 3 items. To evaluate the reliability and validity of the scale, a pilot study was conducted with 42 college students. Exploratory factor analysis was performed using SPSS 25. The results showed that the Kaiser-Meyer-Olkin value was 0.89, the Bartlett's test chi-square value was $\chi2(105) = 755.83$, $p < 0.001$, indicating that this scale was suitable for factor analysis. Each item's factor loading was between 0.57 and 0.88 (Table 1), with all values exceeding the recommended threshold of 0.5, which suggested adequate item effectiveness. Additionally, the Cronbach's α coefficients for the subscales ranged from 0.91 to 0.95 (Table 1), demonstrating acceptable internal consistency.

Table 1 The Reliability and Validity of the Scale

Item	Teacher-student interaction (TSI)	Student-student interaction (SSI)	Student-content interaction (SCI)	Student-platform interaction (SPI)	Deeper learning
TSI1	.78				
TSI2	.69				
TSI3	.62				
SSI1		.62			
SSI2		.77			
SSI3		.72			
SCI1			.82		
SCI2			.75		
SCI3			.76		
SPI1				.70	
SPI2				.74	
SPI3				.57	
DL1					.79
DL2					.77
DL3					.88
Cronbach's α	.91	.94	.93	.95	.93

3.4. Data analysis

First, this study employed a paired samples t-test to analyze pre-test and post-test data, aiming to evaluate whether college students' deeper learning competency demonstrated significant improvement following participation in the online interactive learning. Then, pearson correlation analysis was conducted on the five variables in the post-test data to explore the relationship between the four online interactions and deeper learning competency. Finally, to further investigate the extent to which these four dimensions of interaction predicted perceived deeper learning, a multiple regression analysis was conducted. The significance level was set at $p < 0.05$.

4. Research results and discussion

4.1. College students' perceived deeper learning

As shown in Table 2, college students' perceived deeper learning demonstrated a statistically significant improvement after engaging in online interactive courses ($t = 2.65$, $p < .01$). The result validates the effectiveness of the four-dimensional online interactive course design proposed in this study in fostering deeper learning competency among college students. The quality of online courses extends beyond the mere provision of recorded lectures or instructional materials; rather, it resides in the intentional design of an interactive online environment that serves as a robust foundation for fostering deeper learning (Jiang, 2022). Its key elements include timely, specific, and metacognitive-oriented feedback from instructors; structured and academically meaningful opportunities for peer collaboration; cognitively challenging tasks; and user-centered, interface-friendly technological platforms contribute to creating a rich and supportive environment for college students' deeper learning. This finding not only confirms the practical value of the multi-dimensional interactive teaching but also offers a more refined pathway for optimizing online course design.

Table 2. Comparison of college students' pre-test and post-test perceived deeper learning

	M	SD	*t*	*p*
Pre-test	4.00	.66	2.65	.009
Post-test	4.24	.59		

4.2. Online interaction and perceived deeper learning

Table 3 showed that the teacher-student, student-student, student-content, and student-platform interactions were all positively correlated with college students' perceived deeper learning, with correlation coefficients ranging from 0.60 to 0.68. The results of regression analysis (Table 4) indicated that the four dimensions of interaction accounted for a substantial proportion of the variance in perceived deeper learning ($R^2 = 0.72$). Specifically, student-teacher interaction ($\beta = 0.20$, $p < 0.05$), student-student interaction ($\beta = 0.27$, $p < 0.01$), student-content interaction ($\beta = 0.34$, $p < 0.001$), and student-platform interaction ($\beta = 0.19$, $p < 0.05$) each significantly contributed to predicting college students' perceived deeper learning.

The results align with those of Zhou et al. (2024), who demonstrated that interactive teaching significantly and directly contributes to deeper learning. Notably, student-content interaction exhibits the strongest predictive effect. This implies that to effectively enhance students' perception and confidence in their higher-order cognitive skills, instructional design should prioritize creating learning environments that promote active exploration, critical processing, and internalization of academic content, such as problem-based learning and reflective assignments. At the same time, peer collaboration, instructor guidance, and technological platform support should be integrated as complementary components in a cohesive, multi-layered interaction framework, collectively fostering a dynamic and engaging learning ecosystem that supports students' deeper learning. It advances beyond the limitations of prior research, which has predominantly focused on a single mode of interaction—such as that between teachers and students or among peers—by empirically validating the independent and collaborative predictive power of the four-dimensional interaction framework encompassing teacher-student, student-student, student- content, and student-platform interactions.

Table 3 Pearson's correlation analysis results of college students' interaction and their DL

Dimension	TSI	SSI	SCI	SPI	DL
TSI	1				
SSI	.68**	1			
SCI	.64**	.63**	1		
SPI	.62**	.67**	.66**	1	
DL	.60**	.61**	.65**	.62**	1

Table 4 Regression analysis for college students' interactions predicting their DL

Dimension	*β*	*p*	R2	F
TSI	.20	.029	.72	2245.06***
SSI	.27	.005		
SCI	.34	.000		
SPI	.19	.031		

***$p < 0.001$

5. Conclusion

This study examined the impact of college students' online interaction on their perceived deeper learning and provided empirical validation for the effectiveness of multi-dimensional interaction embedded in online course. The results showed a statistically significant improvement in college students' deeper learning competency after completing the online course, with all four types of interaction (teacher-student, student-student, student-content, and student-platform interactions) serving as significant positive predictors. These results offer practical implications for online course design. Teachers should move beyond passive knowledge transmission and instead cultivate an integrated interactive ecosystem grounded in deep engagement with content, extended through collaborative learning, facilitated by timely teacher support, and enabled by user-friendly technological platforms. The findings contribute empirical evidence and actionable design principles for enhancing the quality of online learning in higher education.

Of course, this study also has several limitations. Firstly, since there is no control group, it is difficult to determine whether the online interactive instructional model proposed in this study is superior to other models. Secondly, the samples are limited to freshmen, and students from different grades have different characteristics, the generalizability of the findings may be constrained. Future research will address these limitations by expanding the sample size and adding a control group, further verify the effectiveness of the online interactive instruction design. Additionally, subsequent studies will explore the relationship between deeper learning competency and academic performance, as well as examine differential learner needs regarding online interaction patterns.

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