EPISTEMA

Vol.6 No.2 2025 | e-ISSN: 2723-8199
https://doi.org/10.21831/ep.v6i2.93217

Article History
Received : 12 December 2025;
Revised : 24 December 2025;
Accepted : 06 January 2026;
Available online : 21 January 2026.

Effect of LMS Live Forum with Deep Learning Approach on Students' Collaborative Skills

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Abstract:
Studi ini menyelidiki pengaruh aktivitas forum langsung LMS yang diintegrasikan dengan pendekatan pembelajaran mendalam terhadap keterampilan kolaboratif mahasiswa pendidikan tinggi. Penelitian ini menggunakan desain satu kelompok pretest–posttest yang melibatkan 30 mahasiswa sarjana yang terdaftar dalam mata kuliah Teknologi Pendidikan di sebuah universitas negeri di Indonesia. Siswa berpartisipasi dalam serangkaian sesi forum langsung sinkron di LMS, yang disusun menggunakan prinsip-prinsip pembelajaran mendalam seperti pertanyaan kritis, eksplorasi konseptual, dan pemecahan masalah kolaboratif. Data tentang keterampilan kolaborasi dikumpulkan menggunakan rubrik berbasis kinerja dan dianalisis melalui statistik deskriptif, uji normalitas Shapiro–Wilk, dan uji-t berpasangan. Hasilnya menunjukkan peningkatan signifikan dalam keterampilan kolaborasi siswa setelah intervensi, dengan skor rata-rata meningkat dari 27,07 menjadi 38,73. Uji-t berpasangan menunjukkan perbedaan yang sangat signifikan (p = .000), dan ukuran efek (Cohen's d = 3.70) menunjukkan dampak intervensi yang sangat besar dan bermakna. Temuan ini menunjukkan bahwa integrasi strategi pembelajaran mendalam ke dalam diskusi LMS sinkron mendorong keterlibatan yang lebih dalam, meningkatkan kualitas interaksi, dan mendukung kinerja kolaboratif yang lebih adil di antara siswa. Disarankan agar pendidik mengadopsi aktivitas forum langsung berbasis pembelajaran mendalam terstruktur untuk memperkuat kompetensi kolaborasi dalam lingkungan belajar digital. Penelitian di masa depan dapat mengeksplorasi efek jangka panjang, sampel yang lebih besar, dan fitur LMS tambahan untuk mengoptimalkan hasil pembelajaran kolaboratif.

This study investigates the effect of LMS live forum activities integrated with a deep learning approach on the collaborative skills of higher education students. The research employed a one-group pretest–posttest design involving 30 undergraduate students enrolled in an Educational Technology course at a public university in Indonesia. Students participated in a series of synchronous live forum sessions in the LMS, structured using deep learning principles such as critical questioning, conceptual exploration, and collaborative problem solving. Data on collaboration skills were collected using a performance-based rubric and analyzed through descriptive statistics, the Shapiro–Wilk normality test, and a paired samples t-test. The results showed a significant increase in students' collaborative skills after the intervention, with the mean score rising from 27.07 to 38.73. The paired t-test indicated a highly significant difference (p = .000), and the effect size (Cohen's d = 3.70) demonstrated a very large and meaningful impact of the intervention. These findings suggest that the integration of deep learning strategies into synchronous LMS

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https://doi.org/10.21831/ep.v6i2.93217

discussions fosters deeper engagement, enhances interaction quality, and supports more equitable collaborative performance among students. It is recommended that educators adopt structured deep learning–based live forum activities to strengthen collaboration competencies in digital learning environments. Future research may explore long-term effects, larger samples, and additional LMS features to optimize collaborative learning outcomes.

Keywords: deep learning approach; LMS live forum; collaborative skills; higher education.

INTRODUCTION

The rapid advancement of digital technology has transformed learning ecosystems in higher education, shifting instructional practices toward more interactive, collaborative, and student-centered approaches. Learning Management Systems (LMS) have become the primary platforms through which universities facilitate these transformations, offering features that support communication, content delivery, assessment, and collaboration. Among these features, *live forums* synchronous discussion spaces that allow real-time exchange of ideas are increasingly recognized for their potential to support meaningful social interaction and collective problem-solving (Coelho et al., 2024; Han & Shin, 2016). Live forums differ from traditional asynchronous forums in that they require students to engage immediately, respond actively, and negotiate understanding in real time, thereby creating conditions that can strengthen collaborative skills.

Collaboration has been identified as an essential 21st-century competency for higher education students. Effective collaboration encompasses not only communication but also coordination, mutual responsibility, perspective-taking, and shared construction of knowledge (Annamalai et al., 2021). In online learning environments, these skills become even more critical because student interactions are mediated through technology, which can either facilitate or hinder meaningful engagement depending on how learning activities are designed. Studies in educational technology emphasize that online collaborative activities must be intentionally structured to support positive interdependence, accountability, and reflective dialogue (Miftah & Cahyono, 2022; Pogorskiy & Beckmann, 2022; Prastiwi & Tukiran, 2024). Without an appropriate pedagogical approach, digital interactions risk becoming superficial, fragmented, or dominated by a few active participants.

Deep learning, as a pedagogical approach, offers a theoretical foundation to design learning experiences that foster active engagement, conceptual understanding, and reflective thinking. Unlike surface learning which focuses on memorization and task completion deep learning encourages students to analyze, evaluate, and apply knowledge to new contexts. According to Dolmans et al. (2016), deep learning promotes cognitive processes such as critical questioning, synthesis of ideas, and integration of new information with prior knowledge. Recent studies Kovač et al. (2025); (Murphy et al., 2025) also highlight that learning environments organized using deep learning principles tend to generate richer student discussions, deeper reflections, and more sustained interactions among group members. When applied to collaborative learning scenarios, the deep learning approach can help students move beyond passive participation, fostering more meaningful engagement and cooperative knowledge-building.

Despite the growing interest in deep learning within technology-enhanced learning research, empirical studies linking deep learning strategies to *collaboration skill development* in synchronous online contexts remain limited. Much of the existing literature

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focuses on asynchronous discussion forums or general online collaborative learning, which offer flexibility but lack the immediacy and dialogic intensity of live interactions (Nungu et al., 2023; Pahi et al., 2024; Potkonjak et al., 2016). The affordances of LMS live forums such as real-time communication, rapid feedback loops, and the spontaneous exchange of perspectives suggest unique potential for strengthening collaboration. However, without appropriate instructional scaffolding, live forums may lead to unstructured interaction, cognitive overload, or unequal participation (Kurniawan et al., 2024). This creates a pressing need to investigate how deep learning principles can be embedded effectively into LMS live forum activities to optimize collaborative skill development.

Research in the Indonesian higher education context on this topic is even more scarce. Although LMS adoption has expanded rapidly across universities, studies examining the pedagogical effectiveness of specific LMS features particularly synchronous discussion tools are still emerging. Furthermore, there is limited empirical evidence assessing how these tools, when integrated with deeper learning strategies, affect students' collaborative skills. Addressing this gap is essential, as Indonesian universities are increasingly prioritizing digital learning innovation and expecting students to demonstrate higher-order thinking and collaboration competencies.

The novelty of this study lies in its integrated approach: it examines how a deep learning–structured LMS live forum can enhance students' collaborative skills through a systematic, empirical investigation. Unlike previous research that typically isolates technological tools from pedagogical strategies, this study explicitly combines both elements into a unified instructional framework. By measuring students' collaboration performance before and after the intervention, the study provides robust evidence of the pedagogical effectiveness of this approach. Moreover, it contributes new insights into how synchronous digital interaction when guided by deep learning principles can support more consistent and equitable collaborative performance across students.

Thus, the purpose of this study is to analyze the impact of LMS live forum activities, designed using a deep learning approach, on the collaborative skills of higher education students. Specifically, the study aims to (1) describe the level of students' collaborative skills before and after the intervention, and (2) determine whether the learning intervention leads to statistically significant improvements in collaboration. The findings are expected to inform instructors, instructional designers, and educational technology practitioners about the potential of combining deep learning strategies with synchronous LMS features to foster more effective digital collaboration.

METHOD

This study employed a one-group pretest–posttest design to examine the effect of LMS SIDIA (UNESA Owned LMS) live forum activities implemented through a deep learning approach on the collaborative skills of higher education students. The interface could be seen on figure 1. The research was conducted in the Educational Technology Department at a public university in Indonesia during the 2024–2025 academic year. A total of 30 undergraduate students participated as research subjects, selected through purposive sampling based on their enrollment in a course that regularly utilized the LMS for learning activities. All participants voluntarily joined the study and completed both the pretest and post-test assessments.

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https://doi.org/10.21831/ep.v6i2.93217

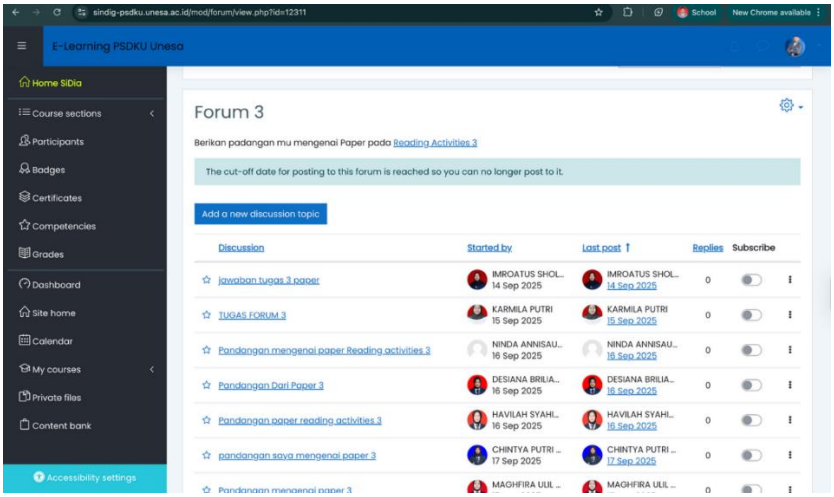

Figure 1. LMS SIDIA UNESA Forum Interface

The intervention was designed to integrate the live forum feature of the institution's LMS with instructional strategies grounded in the deep learning approach. During the learning sessions, students engaged in structured synchronous discussions, problem-solving tasks, and group-based inquiry activities. These activities required students to analyze authentic scenarios, formulate arguments, negotiate meaning, and collaboratively develop solutions in real time. Deep learning principles such as critical questioning, conceptual integration, reflective dialogue, and application of knowledge to new contexts were intentionally embedded into the learning sequence. The instructor acted as a facilitator by providing prompts, scaffolding discussions, and guiding students toward deeper levels of understanding and interaction throughout the live forum activities.

Data on students' collaborative skills were collected using a performance-based collaboration assessment rubric adapted from established indicators of effective teamwork adopted from St. Cloud University (*Copyright 2012, The Academy for Co-Teaching and Collaboration at St. Cloud State University Original Research Funded by a US Department of Education, Teacher Quality Enhancement Partnership Grant).* The instrument measured key dimensions such as communication, coordination, participation equity, shared responsibility, and collective problem solving. The rubric was administered twice: once before the intervention as a pretest, and once after the intervention as a post-test. Students participated in parallel collaborative tasks during both assessments to ensure comparability of scores. Prior to the study, the instrument was validated by two experts in educational technology and instructional design, and demonstrated acceptable reliability for measuring collaborative performance in online learning settings.

The data collection procedure began with administering the pretest during the first meeting, followed by four weeks of instructional sessions using the LMS live forum integrated with the deep learning approach. Each live forum session lasted 60–90 minutes and emphasized synchronous interaction among group members. After the final session, the post-test was administered using the same scoring rubric and procedure as the pretest. All assessments were conducted within the LMS to maintain consistency of the learning environment.

Data were analyzed using descriptive and inferential statistics. Descriptive statistics including mean, standard deviation, range, and distribution characteristics were used to present an overview of students' collaborative skills before and after the intervention. The Shapiro–

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Wilk test was used to assess the normality of the data distribution, given the sample size of fewer than 50 participants. To determine whether there was a statistically significant difference between pretest and post-test scores, a paired-samples t-test was performed at a significance level of .05. Effect size was calculated using Cohen's d to measure the magnitude of the intervention's impact. All statistical analyses were conducted using SPSS version 27.

RESULTS AND DISCUSSION

Table 1. Descriptive Statistic Analysis Result

	Deep Learning			Statistic	Std. Error
Pretest Kolaborasi	1.00	Mean		27.0667	0.60064
		95%Confidence Interval for Mean	Lower Bound	25.8382	
			Upper Bound	28.2951	
		5% Trimmed Mean		27.0741	
		Median		27.0000	
		Variance		10.823	
		Std. Deviation		3.28983	
		Minimum		21.00	
		Maximum		33.00	
		Range		12.00	
		Interquartile Range		4.25	
		Skewness		-0.156	0.427
		Kurtosis		-0.505	0.833
Post test Kolaborasi	1.00	Mean		38.7333	0.31048
		95%Confidence Interval for Mean	Lower Bound	38.0983	
			Upper Bound	39.3683	
		5% Trimmed Mean		38.7407	
		Median		39.0000	
		Variance		2.892	
		Std. Deviation		1.70057	
		Minimum		35.00	
		Maximum		42.00	
		Range		7.00	
		Interquartile Range		2.25	
		Skewness		0.178	0.427
		Kurtosis		0.088	0.833

Collaborative Pre-test and Post-test Comparison

The overall score could be seen on table 1, there was a significant improvement between the pretest and post-test scores of students' collaborative abilities. The higher post-test average score (38.73 compared to 27.06 on the pretest) indicates that students showed improvement in their collaboration skills after learning. The decrease in standard deviation from 3.29 on the pretest to 1.7 on the post-test indicates that the distribution of post-test scores is narrower and more uniform, meaning most students achieved higher and more consistent scores in their collaboration. The smaller range (7 on the post-test compared to 12 on the pretest) reinforces this finding, with post-test scores more focused on the higher end of the score range.

Thus, the learning implemented between the pretest and post-test has been effective in improving students' collaborative abilities, as reflected by the increase in average scores, the reduction in score variability, and the more uniform distribution on the post-test.

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https://doi.org/10.21831/ep.v6i2.93217

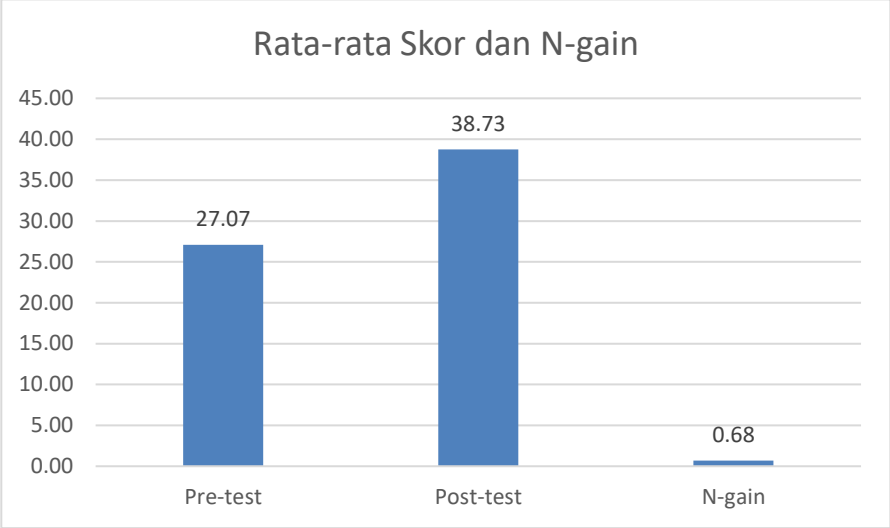

Figure 2. Means and N-Gain Score of Collaborative Skill

According to the figure 2, which shows the average scores and N-Gain of students' collaboration skills in the pretest and post-test, there is a clear picture of the influence of deep learning approach-based learning on improving students' collaboration skills. In the pretest, the average student score was 27.07, indicating that initially, students had a fairly good level of collaboration skills, but there was still room for improvement. This figure reflects a lower level of proficiency compared to the desired standard, although students already demonstrate some basic skills in collaboration. After implementing deep learning, the average post-test score significantly increased to 38.73. This increase indicates that the deep learning method successfully encouraged students to be more active in their learning, collaborate better, and apply these skills in a broader context. Learning that focuses on in-depth experiences, active discussions, and problem-solving is likely to have a positive impact on their collaborative abilities (Kovač et al., 2025; Murphy et al., 2025). This higher score indicates that students were able to work more effectively in teams and manage collaborative tasks better after participating in the learning.

Additionally, the recorded N-Gain value of 0.68 provides insight into the extent of improvement from pretest to post-test. This value of 0.68 indicates a fairly significant improvement, meaning that learning with a deep learning approach has a moderate but quite strong positive impact on students' collaborative abilities. Although there was a considerable increase, this N-Gain value also shows that there is still potential for further improvement, which could be achieved thru more intensive learning approaches or the use of other, more in-depth methods.

Overall, these results indicate that learning with a deep learning approach is effective in improving students' collaborative abilities. Although the increase was already significant, the N-Gain value not reaching the highest number suggests that there is still room for further improvement in teaching techniques, in order to achieve more optimal and uniform results across all students (Bal & Öztürk, 2025).

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Shapiro-Wilk Test for Normality

Table 2. Shapiro-Wilk Test Result

	Deep Learning	Shapiro-Wilk		Deep Learning	Shapiro-Wilk[a]
		Statistic	df		Sig.
Pretest Kolaborasi	1.00	.968	30		
Post test Kolaborasi	1.00	.950	30	1.00	.489
				1.00	.167

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

Based on the results of descriptive statistical tests and the Shapiro-Wilk normality test applied to the student collaboration ability data, several important conclusions were drawn regarding the data distribution in the pretest and post-test of collaboration ability. The Shapiro-Wilk test was used because the sample size was <50.

The Shapiro-Wilk test results for the pretest show a Statistic value of 0.968 with a p-value of 0.489. A p-value greater than 0.05 indicates that the pretest data is normally distributed. In other words, the pretest data on students' collaboration skills does not show any significant deviation from a normal distribution. This means the distribution of pretest scores is not skewed to the left or right and there are no significant outliers, indicating that most students have collaboration skills within a similar range.

Meanwhile, for the post-test, the Shapiro-Wilk test results showed a Statistic value of 0.950 with a p-value of 0.167, which is also greater than 0.05. This p-value being greater than 0.05 indicates that the data in the post-test is normally distributed. This indicates that after learning, students' overall collaborative abilities are still normally distributed, with more uniform values and no significant deviations or unusual distribution patterns. Thus, parametric analysis tests with t-tests can be conducted for further analysis of comparisons between groups or the influence of learning on students' collaborative abilities. Acceptance of this normality assumption strengthens the validity of using more powerful and efficient statistical techniques.

Overall, both the pretest and post-test results indicate that the students' collaboration ability data are normally distributed, as shown by the Shapiro-Wilk test results for both groups. This normal distribution is very important in statistical analysis because many statistical methods, especially parametric analysis, assume that the data used is normally distributed.

One Paired t-test analysis

Table 3. One Paired t-test Result

		Paired Differences							
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper	t	df	Sig. (2-tailed)
Pair 1	Pretest Kolaborasi – Post test Kolaborasi	-11.66667	3.70771	.67693	-13.05115	-10.28218	-17.235	29	.000

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Based on the results of the One Paired T-Test conducted to analyze the difference between pretest and post-test collaboration skills of students, it can be concluded that learning with a deep learning approach has a significant impact on improving students' collaboration skills. Here is a detailed explanation of the results of the statistical test: In the pretest, the average collaboration ability score for students was 27.07, with a standard deviation of 3.28 and a standard error of the mean of 0.6. In the post-test, the average score increased to 38.73, with a smaller standard deviation of 1.70 and a standard error of the mean of 0.31. The significant difference between the pretest and post-test scores indicates that students experienced a substantial improvement in their collaborative abilities after participating in learning with a deep learning approach. This approach is believed to contribute to improved collaboration skills by encouraging students' active participation in a deeper learning process (Dolmans et al., 2016; Du et al., 2025), and also provides an opportunity for critical thinking and teamwork.

The correlation coefficient between the pretest and post-test results is -0.003, which is very close to 0, and the p-value is 0.988. This very low correlation coefficient and very high p-value indicate that although there was a significant improvement, there is no strong linear relationship between the pretest and post-test scores. This could indicate that learning with a deep learning approach successfully improved collaboration skills without being overly influenced by students' initial performance on the pretest. Furthermore, this also correlates with the research findings from Fawzia and Karim (2024); Feriyanto and Anjariyah (2024) which shows that a deep learning approach can help students understand concepts better because the material presented is very specific.

In the paired t-test section, the mean of the differences between pretest and post-test is -11.67, with a standard deviation of differences of 3.71 and a standard error of the mean of 0.68. With a p-value of 0.000, which is less than 0.05, it can be concluded that the difference between pretest and post-test is statistically highly significant. This shows that learning with a deep learning approach successfully brought about real changes in students' collaborative abilities. The effect size calculated using Cohen's d was 3.70 and Hedges' correction was 3.75, indicating a very large effect. A Cohen's d value greater than 0.8 suggests that the impact of learning with a deep learning approach on students' collaborative abilities is highly significant. The use of this approach seems to be very effective in improving students' collaboration skills in an educational context (Gao, 2025; Shaari et al., 2012).

Another important aspect of the analysis involves understanding *why* the deep learning–based live forum had such a pronounced and transformative impact on students' collaborative skills. The deep learning approach is fundamentally designed to position students as active constructors of knowledge, requiring them to engage at cognitive, emotional, and social levels throughout the learning process (Bürgermeister et al., 2021). In this study, the LMS live forum became a space where these dimensions converged. Deep learning emphasizes sustained inquiry, conceptual integration, and reflective engagement, which naturally require continuous interaction with peers (Erbilgin et al., 2023; Garrison et al., 1999). Consequently, the live forum environment demanded not only the expression of individual ideas but also the analysis of others' contributions, the negotiation of differing viewpoints, and the justification of reasoning through evidence and logical argumentation (Munawaroh & Rahmadonna, 2023). These activities constitute the core of collaborative knowledge building and have been consistently linked to the development of higher-order skills such as critical thinking, metacognition, and interpersonal communication.

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During the synchronous sessions, students were exposed to real-time exchanges that required them to think on their feet, articulate thoughts coherently, evaluate peer responses rapidly, and adapt their communicative strategies. This immediacy distinguishes live forums from asynchronous discussion boards, where students typically have more time to formulate responses (López-Pellisa et al., 2020; Pahi et al., 2024). In contrast, the synchronous live forum more closely mirrors authentic collaborative settings found in professional environments, thereby fostering a heightened sense of social presence and accountability. The real-time format likely increased students' cognitive engagement, as they needed to monitor the flow of discussion, integrate multiple ideas, and collaboratively construct solutions under time-sensitive conditions. Such interactive dynamics not only strengthen individual understanding but also promote interdependence, as students rely on one another's input to move the discussion forward meaningfully.

Moreover, the emotional and social dimensions of deep learning were activated in the live forum environment. The necessity to respond immediately creates a heightened sense of involvement and attentiveness, reducing opportunities for passive participation. Students became more attuned to their peers' perspectives, developing empathy, active listening skills, and an appreciation for diverse viewpoints (van der Stap et al., 2024; Wei & Liu, 2024). These interpersonal competencies are crucial for effective collaboration and often develop more robustly in synchronous interaction than in asynchronous formats (Andrews et al., 2020). The shared experience of co-constructing knowledge in real time also contributed to a stronger sense of community and collective responsibility, elements that enhance group cohesion and ultimately influence the quality of collaborative outcomes.

Finally, the integration of deep learning promptssuch as probing questions, reflective prompts, and scenario-based tasksfurther amplified the collaborative potential of the live forum. These instructional elements pushed students beyond surface-level responses toward deeper analysis, synthesis of ideas, and generation of novel solutions. The continuous cycle of presenting ideas, receiving peer feedback, revising understanding, and collectively building new insights created a dynamic learning environment conducive to the development of advanced collaboration skills. Taken together, these cognitive, emotional, and social mechanisms help explain why the deep learning–based live forum exerted such a strong and measurable impact on students' collaborative performance.

Overall, the results of the Paired T-Test show that learning with a deep learning approach not only improves students' average collaboration skills but also produces a significant difference with a very large effect. This improvement in collaboration skills is most likely related to the deep learning methodology, which encourages active student engagement, as well as their ability to think critically and work in teams. Thus, it can be concluded that the deep learning approach has a significant positive impact on improving students' collaboration skills.

CONCLUSION

This study aimed to examine the effect of LMS live forum activities designed with a deep learning approach on the collaborative skills of higher education students. The findings provide strong evidence that the integration of deep learning principles into synchronous online discussion activities significantly enhances students' ability to work collaboratively. The results of the descriptive statistics, normality testing, and the paired samples t-test consistently demonstrated substantial improvement from pretest to post-test scores. The increase in mean scores, reduction in score variability, and exceptionally large effect size indicate that the

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intervention not only improved average performance but also supported more uniform development of collaboration skills among students.

The findings suggest that the structure and nature of the deep learning–based live forum were instrumental in facilitating these improvements. Real-time interaction combined with deep learning elementssuch as critical questioning, reflective dialogue, and collaborative problem solvingprovided conditions that encouraged deeper engagement, more active participation, and more meaningful social interaction. These learning experiences allowed students to practice essential components of collaboration, including communication, negotiation, shared responsibility, and coordinated decision-making. As a result, students were better able to articulate ideas, respond constructively to peers, and build collective understanding through synchronous digital interaction.

The results of this study imply that integrating deep learning approaches into LMS live forum activities can serve as an effective instructional model for promoting 21st-century collaborative competencies. Educators and instructional designers are encouraged to incorporate structured prompts, problem-based tasks, and guided facilitation strategies in synchronous online discussions to maximize student engagement and collaborative learning outcomes. The approach is particularly relevant in higher education contexts where digital learning environments are becoming increasingly central to teaching and learning practices.

While the results are promising, this study was limited to a single group design and a relatively small sample size. Future research could employ quasi-experimental or mixed-method designs to explore the causal mechanisms more comprehensively and capture students' perceptions and interaction patterns during synchronous sessions. Additional studies could also investigate the long-term effects of deep learning–based live forums on collaboration, as well as their integration with other LMS features such as breakout rooms, collaborative documents, or peer-assessment tools.

Overall, this study concludes that LMS live forums grounded in a deep learning approach can meaningfully and significantly improve students' collaborative skills. The integration of pedagogical depth with synchronous digital interaction presents a powerful model for enhancing collaborative learning in technology-rich higher education settings.

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