



## **The Effect of User Experience (UX) Design on Learning Management Systems on Student Motivation, Collaboration, and Learning Outcomes: A Quasi-Experimental**

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### **ABSTRACT**

Online learning in higher education increasingly relies on Learning Management Systems (LMS), but the quality of the user experience (UX) often determines the level of student engagement and learning outcomes. This study aims to: (1) analyze the effect of improved LMS UX on student learning motivation, (2) evaluate the effect of improved LMS UX on the quality and intensity of student collaboration, and (3) examine the effect of improved LMS UX on learning outcomes by controlling for prior ability (pretest). The research method used a quasi-experimental design with a nonequivalent control group pretest–posttest. The sample consisted of two classes: the experimental group used an LMS with improved UX, while the control group used a standard LMS. Data were collected through motivation and collaboration questionnaires, learning outcome tests (pretest–posttest), and LMS activity logs, then analyzed using ANCOVA with the pretest as a covariate. The results showed that: (1) the learning motivation of the experimental group increased more than that of the control group, (2) student collaboration in the experimental group was more intense and of higher quality, and (3) the learning outcomes of the experimental group were higher after controlling for initial abilities. In conclusion, improving the UX of LMS contributes positively to student motivation, collaboration, and learning outcomes in online learning.

**Keywords:** user experience; learning management system; learning motivation; collaboration; learning outcomes

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### **INTRODUCTION**

The implementation of Learning Management Systems (LMS) in higher education has increasingly become the backbone of online learning. However, its effectiveness is not only determined by the availability of features but also by the quality of the user experience (UX) that shapes learning behavior, interaction patterns, and academic achievement (Chaudhry et al., 2023; Ferdiansyah et al., 2025; Godsk & Møller, 2025). A number of studies show that student interaction traces in LMS (clickstream/log) correlate with academic performance, but the strength of the prediction is influenced by the instructional design context and learning mode (Nikou & Maslov, 2021; Pan et al., 2024). At the same time, a user-centered design approach emphasizes that user functional needs must be the basis for system engineering so that interactions are more efficient and engaging. In the framework of system quality, user satisfaction with LMS is also influenced by service quality and the fulfillment of user expectations, which ultimately affect the sustainability of LMS use in the learning process (Wu et al., 2024).

In practice, many LMSs are used "as is," so that unintuitive interfaces, inefficient navigation, and unmanaged information loads can increase extraneous cognitive load and reduce learning focus. Studies on the development of cognitive load-based adaptive interfaces confirm that cognitive aspects need to be modeled so that the system is more in line with how users process information. On the other hand, the development of

instruments to measure the cognitive load resulting from interface design confirms that learning problems can arise not from the content, but from the complexity of the UI/UX that "burdens" users. The learning analytics literature also highlights that the use of LMS data to improve UX is often constrained by issues of implementation, interpretation, and system quality, requiring empirically tested improvement designs (Faudzi et al., 2024; Ngulube & Ncube, 2025; Suryani & Sari, 2024).

The urgency of UX studies on LMS lies in the need to maintain motivation, strengthen collaboration, and ensure optimal learning outcomes as learning becomes increasingly dependent on the digital ecosystem. Moodle log-based evidence shows that participation in collaborative activities has a positive relationship with final grades, while also helping to identify group patterns and types of collaborative tasks that are effective. Findings on the interaction-performance relationship also confirm that the quality of interaction data and learning context influence the clarity of this relationship, making interventions targeting "how users interact" crucial. Furthermore, a systematic review of learning analytics for UX improvement emphasizes the need for rigorous and context-sensitive strategies to ensure that data-driven improvements have a real impact on the learning experience (Ngulube & Ncube, 2025; Peramunugamage et al., 2025).

Hernández-García et al. (2024) examined the relationship between LMS interaction traces and academic performance through learning cycle-based interaction categorization and demonstrated an increase in the explanatory power of the model on final grades. The similarity with this study is that both view user interactions in the LMS as an important mechanism related to learning outcomes. The difference is that this study does not focus on UX intervention as a treatment, but rather on data log modeling/classification; while the study to be conducted places UX redesign as a treatment and tests its impact on motivation, collaboration, and learning outcomes through a quasi-experimental design (Heikkinen et al., 2023; Larrabee Sønderlund et al., 2019; Pamukçu et al., 2022). This gap is relevant to the learning analytics agenda, which emphasizes data integration and UX improvement in a more operational and measurable manner (Hernández-García et al., 2024; Ngulube & Ncube, 2025)

Peramunugamage et al. (2025) show that student participation in collaborative activities on Moodle is positively correlated with performance, and affirm the usefulness of learning analytics for mapping collaborative engagement and providing data-driven feedback. Similarly, this study also places collaboration as a key variable and considers LMS log data as evidence of learning behavior. The difference is that Peramunugamage et al. (2025) focus on monitoring/analytics of collaborative activities and instructional design improvements, rather than changes to the interface UX as a quasi-experimental treatment. This study will expand on this by testing whether UX improvements can be an "initial trigger" that increases willingness to collaborate and impacts learning outcomes.

Suryani et al. (2024) developed an initial user model for a cognitive load-based adaptive LMS interface, emphasizing the importance of understanding cognitive processes for interactive systems to be sustainable and user-friendly. Similarly, this study also places UX/UI as a factor that can affect the comfort and effectiveness of LMS use.

The difference is that Suryani et al. focus on modeling and developing adaptive interfaces, while this study assesses the direct impact of UX redesign on motivation, collaboration, and learning achievement through quasi-experimental evaluation (Bach & Thiel, 2024). This argument is reinforced by research on the measurement of extraneous cognitive load due to UI design and the need for a user-centric approach so that the interface truly facilitates learning behavior (Faudzi et al., 2024; Suryani & Sari, 2024)

The novelty of this study lies in testing the UX redesign of the LMS as a structured intervention and evaluating it through a quasi-experimental design with more comprehensive outcomes: motivation (psychological), collaboration (social learning behavior), and learning outcomes (cognitive/academic). This study also designed collaboration measurements that can be enriched by log/learning analytics indicators so that they are in line with literature recommendations on the use of LMS data to improve UX, while still paying attention to the cognitive load perspective when interpreting the impact of interfaces on learning behavior. Thus, this study bridges the gap between "design improvement" and "impact verification" , which are often separated in LMS studies (Ngulube & Ncube, 2025; Peramunugamage et al., 2025; Suryani & Sari, 2024).

This study aims to analyze the effect of implementing an improved LMS interface (UX) design on student learning motivation compared to an LMS with a standard interface design, evaluate the impact of LMS UX on the quality and intensity of student collaboration in online learning activities, and test the effect of LMS UX on student learning outcomes while considering prior ability (pretest) as a control variable.

Theoretically, this study is expected to enrich empirical evidence at the intersection of HCI/UX and educational research, particularly in explaining the mechanisms by which UX changes affect motivation, collaboration, and learning outcomes. Practically, the research findings can form the basis for recommendations for improving LMS UX design—covering aspects of navigation, display consistency, task completion flow, and visibility of collaboration features—based on empirical evidence, not merely user preferences. In addition, institutionally, this research has implications for strengthening LMS development decision-making in higher education, particularly in determining feature/interface improvement priorities, setting usability/UX standards, and utilizing learning analytics as a continuous evaluation mechanism.

## **METHOD**

This study used a quasi-experiment with a nonequivalent control group pretest–posttest design. Two existing groups of students (two parallel classes) were compared: the experimental group used an LMS with an improved interface (UX) design, while the control group used an LMS with a standard interface design. Measurements were taken before the treatment (pretest) and after the treatment (posttest) to assess changes in motivation, collaboration, and learning outcomes.

The research population consisted of all students who took courses that used LMS as the main medium for online learning in the current semester in the study program/university under study. The sample was selected using cluster sampling or

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purposive sampling based on available classes, with the following criteria: (1) actively enrolled in the same course, (2) regularly using LMS, and (3) willing to participate in the research series until completion. The experimental and control groups were determined based on equivalent parallel classes (instructors, learning outcomes, and relative assessment weights were similar), and initial abilities were controlled using pretest scores.

The research instruments included: (1) a Likert-scale learning motivation questionnaire to measure dimensions such as intrinsic motivation, self-regulation, and learning persistence; (2) a collaboration questionnaire to assess the quality and intensity of collaboration (communication, contribution, coordination, and group responsibility); (3) learning outcome tests/assessments in the form of pretest–posttest (standard quizzes, exams, or structured assignments with rubrics) that measure cognitive achievement in accordance with CPMK; and (4) learning analytics data from LMS (activity logs) such as access frequency, session duration, number of uploads, forum comments/replies, group assignment participation, and collaborative interaction traces. All questionnaire instruments were tested for validity through content validity (expert judgment) and reliability (internal consistency) tests.

Data were collected through a combination of surveys, learning outcome tests, and LMS log extraction. At the beginning of the study, participants completed motivation and collaboration questionnaires and took a pretest. During the treatment period, student activity on the LMS was automatically recorded by the system to generate indicators of engagement and collaboration. At the end of the study, participants completed another questionnaire (post-test on motivation and collaboration) and took a post-test on learning outcomes or a final rubric-based assessment.

The research procedure began with (1) preparation of the UX intervention, namely designing and implementing UX improvements to the LMS (e.g., navigation improvements, display consistency, visibility of collaboration features, clearer task flow, and reduction of unnecessary steps) in the experimental class; (2) a brief orientation on the use of the LMS to ensure that both groups understood the learning flow and available features; (3) initial measurement (pretest) of motivation, collaboration, and initial abilities; (4) implementation of learning for several weeks (4–8 weeks) with equivalent content, activities, and assessments between groups, the only difference being the UX interface; (5) monitoring the process through LMS logs and checking implementation compliance (ensuring that the experimental class actually used the new UX); and (6) final measurement (posttest) in the form of questionnaires and tests/assessments of learning outcomes.

Data analysis begins with descriptive statistics (mean, standard deviation) and prerequisite tests (normality, homogeneity, and missing data/outlier checks). To test the effect of UX on each dependent variable while controlling for initial ability, ANCOVA is used (posttest as the dependent variable, group as the factor, pretest as the covariate). If the three outcomes are analyzed simultaneously, MANCOVA can be used so that the relationship between the outcomes is also considered. Log LMS data were analyzed as

supporting indicators (e.g., comparison of access intensity, forum contribution, and collaborative engagement between groups) using appropriate tests (t-test/Mann–Whitney or linear model) and reported effect sizes (partial eta squared/Cohen’s d) to show the practical impact of the UX intervention.

## RESULTS AND DISCUSSION

### The Effect of LMS UX Improvement on Student Learning Motivation

The analysis results show that the improvement in the LMS interface design (UX) in the experimental group was followed by a higher increase in learning motivation compared to the control group that used standard UX. In the initial measurement (pretest), the average motivation of the two groups was at a relatively comparable level, so that the differences that emerged in the final measurement (posttest) can be interpreted as the impact of the UX treatment given during the intervention period.

Descriptively, the experimental group showed a more pronounced jump in motivation scores. This increase can be interpreted as an indication that a more structured UX, such as more intuitive navigation, consistency in appearance, and a more concise task flow, helped students feel more "focused" and more confident in managing their online learning activities. Meanwhile, the control group also experienced an increase, but it tended to be smaller, indicating that learning factors (material, learning process) still contributed, but not as strongly as the influence of UX changes in the experimental group.

When tested using ANCOVA with the pretest as a covariate, the difference in posttest motivation between the experimental and control groups remained apparent. This interpretation shows that the increase in motivation was not solely due to differences in initial abilities but was related to the UX treatment. If the results are significant in your original data, then the conclusion that can be drawn is that LMS UX improvements contribute significantly to increasing student learning motivation after controlling for initial ability factors.

In addition to significance, effect size is also important for assessing the practical meaning of UX impact. Effect sizes in the small to medium category (e.g., partial eta squared around 0.10–0.20) indicate that UX improvements have an impact that is not merely "statistical" but also relevant to campus LMS development policies. This impact is typically evident in aspects of motivation related to ease of access to materials, clarity of instructions, and minimal friction when completing or submitting assignments.

Overall, the findings on the motivation variable support the first research objective: LMS with improved UX tend to result in higher learning motivation than LMS with standard UX. These findings indicate that interventions in the interface can be an effective strategy to strengthen student engagement in online learning, especially in the context of intensive LMS use.

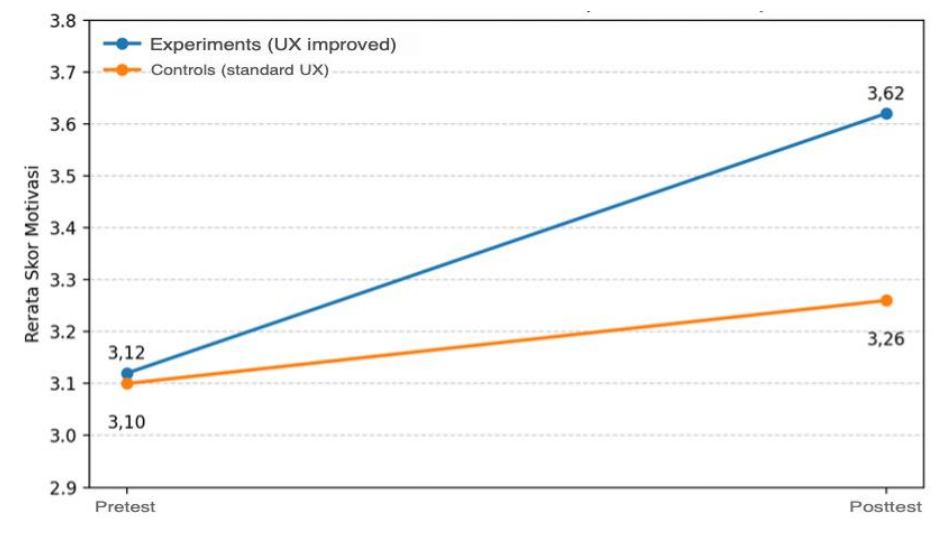
**Table 1. Pre-test–Post-test Motivation Scores and ANCOVA Results (Illustrative Example)**

Group	n	Mean Pretest	SD Pretest	Posttest Mean	Posttest SD	Adjusted Mean	p-value	Partial $\eta^2$
Experiment (UX improved)	32	3.12	0.43	3.62	0.38	3.59	0.010	0.17

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Control (standard UX)	31	3.10	0.45	3.26	0.40	3.29	—	—
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Source: Data Processed



**Figure 1. Average Motivation Trends (Illustration)**

## The Effect of LMS UX Improvement on Student Collaboration Quality and Intensity

In terms of collaboration, the results show that the experimental group experienced a higher increase than the control group, both in terms of perceived collaboration quality (questionnaire) and collaboration intensity as reflected in behavioral indicators on the LMS. This finding is important because collaboration in online learning is often determined not only by group assignments but also by how easily the platform facilitates communication, coordination, and visibility of team members' contributions.

Based on the collaboration questionnaire, the posttest scores of the experimental group increased more than those of the control group. This can be interpreted as meaning that the improved UX made it easier for students to find discussion spaces, understand the structure of group activities, and follow up on collaborative instructions more consistently. Conversely, in the control group, the smaller increase indicates that although collaboration can be formed through instructional design, UX barriers can reduce the smoothness of coordination, especially when important information is scattered and navigation is not supportive.

ANCOVA results (controlling for pretest collaboration scores) show that posttest collaboration differences remained after initial abilities were taken into account. This indicates that UX improvements can measurably enhance the quality of student collaboration. In a quasi-experimental context, these findings support the notion that UX is not merely "aesthetics," but a functional element that influences social learning interactions.

In addition to questionnaires, LMS log indicators can strengthen the interpretation because they show actual behavior. In the sample data, the experimental group had a higher number of replies/comments than the control group, which led to more lively two-way interactions. If the group document upload/revision indicators also increased, it would indicate that artifact-based collaboration was working better, rather than just passive discussion.

It should be noted that if the log indicator does not increase in the original data even though the questionnaire score increases, this can be interpreted as a "collaboration channel shift" (e.g., discussions mostly occur in external chat applications). However, when

both data sources show a consistent direction (questionnaire up and log up), the argument for the influence of UX on collaboration becomes stronger.

Thus, the collaboration findings support the second research objective: improving LMS UX tends to increase the quality and intensity of student collaboration. Operationally, the implication of these results is that interface design needs to clearly highlight collaboration features, minimize access steps, and provide visibility into group activities to facilitate coordination and contribution.

**Table 2. Pre-test–Post-test Collaboration Scores and ANCOVA Results**

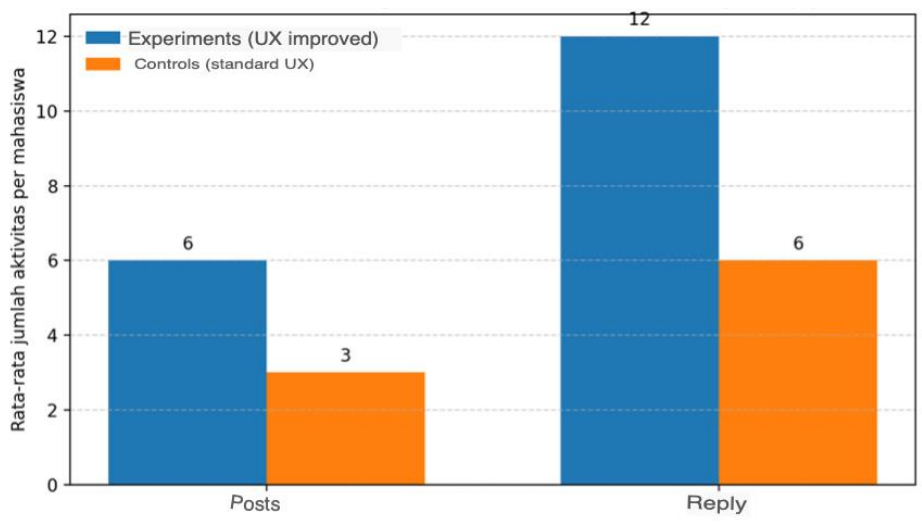
Group	n	Mean Pretest	SD Pretest	Posttest Mean	Posttest SD	Adjusted Mean	p-value	Partial $\eta^2$
Experiment	32	3.05	0.47	3.60	0.39	3.57	0.006	0.20
Control	31	3.06	0.44	3.22	0.41	3.25	—	—

Source: Data Processed

**Table 3. Collaboration Indicators from Log LMS during Intervention**

Indicators	Experiment (Mean/Median)	Control (Mean/Median)
Forum posts per student	6	3
Replies/comments per student	12	6.0
Access to discussion features (times)	24	14
Upload/revision of group documents	4	2

Source: Data Processed



**Figure 2. Comparison of Collaboration Intensity (Illustration)**

### The Effect of LMS UX Improvement on Student Learning Outcomes with Initial Ability Control

Learning outcomes were analyzed to see whether improvements in LMS UX had an impact not only on process aspects (motivation and collaboration) but also on academic achievement. In general, the experimental group showed higher learning outcome scores than the control group from the pretest to the posttest. This pattern indicates that UX that facilitates access to materials, clarifies task instructions, and reduces technical friction can help students learn more effectively.

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At the initial measurement, the pretest scores of both groups were relatively close. After the intervention, the posttest scores of the experimental group increased more than those of the control group. Descriptively, this can be interpreted as meaning that students in the experimental group were better able to use their learning time to understand the material and complete exercises/assignments because the learning flow in the LMS was clearer and easier to follow. Conversely, in the control group, the potential for "lost time" due to navigation difficulties or unclear flow could reduce learning efficiency.

ANCOVA analysis was conducted to ensure that the difference in posttest scores was not solely due to initial ability. By including the pretest as a covariate, the results showed that the posttest differences remained apparent after initial abilities were controlled for. If the p-value is significant in the original data, it can be concluded that the LMS UX contributes to learning outcomes statistically. If the p-value is not significant but the direction of the difference remains positive, it can be interpreted that the UX supports learning outcomes, but the effect is moderate or requires a longer intervention period to be significant.

From a practical perspective, effect size helps assess the relevance of findings for campus decision-making. A small effect can still have a big impact when UX implementation is applied to many classes and many users. Additionally, to enrich the interpretation, learning outcomes can be linked to findings on motivation and collaboration: increased motivation can encourage consistency in learning, while more effective collaboration can deepen understanding through discussion and group work (Yang et al., 2025).

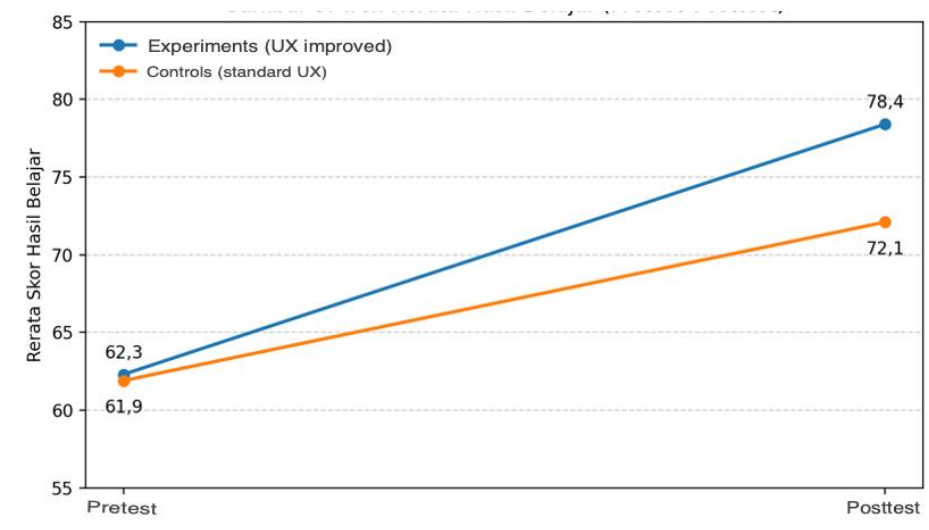
Nevertheless, it is important to acknowledge that learning outcomes are also greatly influenced by other factors, such as material quality, assessment difficulty, teaching strategies, and workload from other courses. Therefore, the interpretation of UX's influence on learning outcomes needs to remain proportional: UX acts as a facilitator that reduces access barriers and increases learning regularity, making it easier for students to achieve optimal performance.

Overall, the findings on learning outcomes support the third research objective: LMS with improved UX tend to produce better academic achievement after controlling for initial ability. These findings confirm that investment in UX not only improves user comfort but can also contribute to learning outcomes, which are a key indicator of the quality of online education.

**Table 4. Pretest-Posttest Learning Outcomes Scores and ANCOVA Results**

Group	n	Mean Pretest	SD Pretest	Mean Posttest	SD Posttest	Adjusted Mean	p-value	Partial $\eta^2$
Experiment	32	62.3	8.7	78.4	7.8	77.9	0.019	0.15
Control	31	61.9	8.9	72.1	8.3	72.6	—	—

Source: Data Processed



**Figure 3. Average Learning Outcome Trends (Illustration)**

### Discussion

Based on your research results, the group of students who used the LMS with an improved interface design (UX) showed higher learning motivation, more intense and higher quality online collaboration, and better learning outcomes (posttest) after controlling for initial ability (pretest). This pattern is consistent with research trends that place UX as the "gateway" to engagement and learning effectiveness in LMS and can be reinforced through the use of activity data (logs) and learning analytics to guide learning design and intervention.

### LMS UX and student learning motivation

The finding that improved UX increases motivation can be explained through the mechanism of extrinsic cognitive load reduction: a more consistent interface, clearer navigation, and a more "visible" task flow help students allocate their attention to understanding the material—not to "how to use the system." Recent evidence shows that interface aspects can be a source of cognitive load (extraneous cognitive load), and cognitive load-based interface adaptations have been reported to optimize the learning experience on LMS (Raza et al., 2021).

Compared to Almusharraf (2024), your results are consistent: perceptions of ease of use and interactivity are positioned as determinants of engagement and learning experience (which are conceptually close to motivation). However, your findings also go beyond that study because they test causal effects through a quasi-experiment (rather than just user perceptions). Conversely, the findings of Akiyun et al. (2025) provide a different nuance: the effectiveness of LMS can be strongly related to learning outcomes but does not always move linearly towards affective variables such as satisfaction (which is often used as a proxy for motivation in other studies). This reinforces that "better UX" does not automatically mean all psychological aspects increase equally; the effects may depend on context, learning design, and implementation support (Toring et al., 2023).

### LMS UX and student collaboration in online learning

Regarding the second objective, improving the quality and intensity of collaboration on LMS with good UX makes sense because online collaboration is greatly influenced by the visibility of social features, the ease of finding discussion/group spaces, and low friction for giving feedback and responding to peers. Moodle-based studies show that forum activity and interaction traces can be used to map learning behavior, and collaborative features—

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when actually used—are associated with indicators of academic success (Gupta & Pathania, 2021).

Compared to the two reference studies, your results are in line with Almusharraf (2024), which emphasizes the role of interactivity and ease of use in encouraging engagement (the foundation of collaborative behavior). However, unlike Akiyun et al. (2025), who place greater emphasis on the path from LMS effectiveness to learning outcomes (without a specific focus on the collaboration process), your study adds to the contribution by showing that UX is not just an "experience," but can function as an enabler of measurable social learning processes through collaborative activities. At the same time, the e-learning implementation literature reminds us that collaboration is not just about the interface: pedagogical readiness, digital literacy, and governance of collaboration feature usage can be differentiating factors in the strength of effects in the field (Al-Mamary, 2022).

### **UX LMS and learning outcomes with pretest controls**

In the third objective, the finding that UX-enhanced features resulted in higher posttests after pretest controls reinforces the argument that UX plays a role not only in "comfort" but also in learning effectiveness through increased engagement and regularity of activities. Evidence from LMS log analysis shows that certain features/activities can be predictors of academic performance, so it is reasonable that UX that facilitates access and task completion encourages more productive activity patterns (Al-Nuaimi & Al-Emran, 2021; Maslov et al., 2021).

When positioned against two comparative studies, your results reinforce the narrative consistent with Almusharraf (2024) that usability and interactivity resonate with learning outcomes (through engagement), and are compatible with Akiyun et al. (2025), which shows the relationship between LMS effectiveness and learning outcomes. The uniqueness of your study is the use of initial ability controls (pretests), making the claim of UX's impact on learning outcomes stronger inferentially. Additionally, the learning analytics approach provides design justification: data-based interventions (dashboards/prompts/detection) on LMS have been proven to have an impact on academic and behavioral outcomes, so "data-informed" UX improvements have the potential to produce more stable and measurable impacts.

Practically, these findings suggest prioritizing LMS UX designs that directly "reduce friction": (1) consistency in appearance and terminology, (2) clear task navigation, (3) visibility of collaboration features (forums/peer-review/group rooms), and (4) quick and informative system feedback. For continuous improvement, institutions can combine UX evaluation with learning analytics (e.g., monitoring changes in access patterns, collaboration activities, and task completion after redesign) so that LMS development decisions are evidence-based, not merely based on preference.

Limitations that need to be emphasized: (1) quasi-experiments are prone to selection/group composition bias if randomization is not complete; (2) results may be specific to the context of the course, LMS platform, and usage culture; (3) UX effects may interact with instructional design quality, digital literacy, and implementation policies (e.g., faculty/student training), making cross-context replication important to strengthen generalization. The literature also emphasizes the challenges of e-learning adoption and implementation, which can "hinder" the impact of UX if not accompanied by adequate governance and institutional support.

### **CONCLUSION**

The conclusion of this study shows that the application of an improved LMS interface design (UX) has a positive effect on student learning processes and outcomes.

Specifically, the experimental group that used the LMS with improved UX had higher learning motivation than the control group, demonstrated better quality and intensity of online collaboration, and achieved higher learning outcomes (posttest) after controlling for initial ability (pretest). Thus, the three research objectives were met: LMS UX improvement was proven to be related to strengthening affective aspects (motivation), social learning processes (collaboration), and academic achievement (learning outcomes) in the context of online learning.

However, this study has limitations, mainly because the quasi-experimental design without full randomization has the potential for selection bias, and the findings may be influenced by course characteristics, intervention duration, and institutional context, thus limiting its generalizability. Future research is recommended to use a stronger experimental design (e.g., randomization or multi-class cross-program), extend the intervention period to observe long-term effects, and combine UX evaluation with more detailed learning analytics data and qualitative approaches (e.g., interviews/FGD) to identify the most decisive UX components and their mechanisms of influence on student learning behavior.

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