MEDIATING EFFECT OF COLLABORATIVE LEARNING ON LEARNING MANAGEMENT SYSTEM USAGE AND ACADEMIC PERFORMANCE

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ABSTRACT

This study aims to identify the mediating effect of collaborative learning on the relationship between Learning Management System (LMS) usage and academic performance among undergraduate students in a public university through the constructivism theory. The study employed a purposive sampling survey method, and 381 valid respondents were collected. Data analysis was conducted based on the Partial Least Square Structural Equation Model (PLS-SEM). As a result, LMS usage positively impacts the academic performance of the students. Besides, LMS usage significantly impacts collaborative learning, and collaborative learning positively influences academic performance. Lastly, collaborative learning was found to exert a partial mediating effect on the relationship between LMS usage and academic performance. This research contributes to the existing literature and illustrates that collaborative learning through LMS can enrich learning activities and promote group discussions. Conclusion, implications, and avenues for future research are discussed.

Keywords: *academic performance, collaborative learning, Learning Management System (LMS), online learning, quality education*

INTRODUCTION

A Learning Management System (LMS) is considered a web-based learning system that facilitates the learning and instructing process, enabling learning activities for fulfilling academic requirements in an educational context (Altinpulluk & Kesim, 2021). With the development of educational technology, the LMS has been widely applied in the higher educational context (Chan et al., 2021a; Samaila et al., 2017). By applying LMS in the process of students' learning, students are allowed to conduct learning activities such as collaborative discussion, group learning, and academic training (Bradley, 2021). Additionally, students also can download pedagogical materials and engage in online lessons provided by their instructors (Samaila et al., 2017). Furthermore, from a communication viewpoint, students are enabled to enhance their cognitive skills and problem-solving strategies through active communication, such as asking questions to, explaining to, and discussing with their classmates (Warsah et al., 2021). Building on the perspective of Altowairiki (2021), LMS systems enable students to have synchronous and asynchronous interactions by actively chatting with others and receiving responses. In the process of LMS-based communication, students can discuss their course-related ideas, share their opinions, and listen to feedback. Such a process of communication can improve the level of their

pedagogical knowledge. Therefore, by utilizing online LMS, the users would become independent in their learning, as the learning process can be monitored by the LMS (Al-Fraihat et al., 2020).

Nowadays, various LMS have been applied in an educational context, such as Blackboard, WebCT, and Moodle (Kushwaha et al., 2019). In Malaysia, the majority of universities, such as Universiti Kebangsaan Malaysia, Universiti Malaysia Sarawak, and Universiti Sains Malaysia (Zamri & Hashim, 2022), have launched online classes by applying a LMS. Due to the outbreak of the Coronavirus pandemic starting in 2019, Covid-19 cases gradually increased in the majority of countries in the world in early 2020. This has led to uncertainties in the educational context. For instance, the closure of universities was implemented by the government. Hence, numerous academic activities, such as conferences and workshops, have been cancelled and put off (Omar et al., 2021). In addition, under the influence of the pandemic, competitive tests, semester examinations, and university admissions are taking place as well (Omar et al., 2021). The temporary closure has changed the structure of learning and the operation of universities. For instance, the methodologies of instructing and assessment were impacted (Tarkar, 2020). The form of student classes has been shifted from face-to-face to online teaching (Omar et al., 2021).

In Malaysia, the Ministry of Education announced that all teaching and learning activities must be carried out in virtual forms until December 31, 2020, in response to the outbreak of Covid-19 (Al-Kumaim et al., 2021). According to Lim et al. (2020), higher education has been working on accelerating the penetration of blended learning by integrating more distance courses with digital technologies, which are conducive to constructing a virtual collaborative learning context and supporting the students' efficient and comprehensive learning process.

Online learning was implemented as a beneficial alternative teaching method for educational institutions during the Covid-19 pandemic. Since the outbreak of Covid-19, LMS-based online learning has been applied as a replacement to support academic studies among students. Online learning began in Malaysian higher educational institutions in 1996 (Rosman et al., 2022), which was proposed by the Ministry of Education in Malaysia as a plan for the Malaysian higher education scenario from 2015 to 2025, stepping up to the transformation towards global online education (Hussein & Hilmi, 2021).

Building on the perspective of Abuhassna et al. (2024), the Covid-19 pandemic presented a long-lasting impact on the circumstances of online learning in Malaysia. For instance, online learning is not fully implemented in post-pandemic, and Malaysian higher educational institutions have been switching back to offline learning from distance learning (Kamaludin & Sundarasen, 2023). Besides, the integration of online course-related discussions into offline conceptual development is suggested as an effective way of learning (Topping et al., 2024).

Despite the benefits for students in terms of their learning, the usage level of the LMS among students was still low, especially during the outbreak of Covid-19 (Ibrahim et al., 2021). This is owing to the sudden emergency temporary shutdown of the education system, which leads to some challenges. For instance, there is a lack of time for adequate training on virtual learning among students, or for getting used to the whole paradigm transformation to online learning (Ibrahim et al., 2021). Besides, there are also other characteristics leading to the challenges of using the LMS, including scarcity of knowledge on information communication technology, poor network platforms, and internet experience (Almaiah et al., 2020). In addition, the full transformation of face-to-face education into distance learning also created challenges for university educators. According to Yusuf and Ahmad (2020), the implementation of LMS systems in Malaysia requires massive efforts from lecturers. For instance, they were required to enhance their knowledge and understanding in terms of the LMS systems by absorbing and comprehending more technical skills. Malaysian universities were also challenged by the provision of sufficient internet facilities and online instructions at the stage of LMS pre-implementation (Yusuf & Ahmad, 2020).

Although the role of online learning on student's academic performance in an educational context has been investigated by various researchers (Chan et al., 2021a; Mandasari, 2020; Oducado & Estoque, 2021; Suresh et al., 2018), there is an inconsistent outcome in terms of the impact of

LMS usage on students' academic performance. On the one hand, Gopal et al. (2021) reveals a positive effect of LMS usage on students' academic performance. However, Tus et al. (2021) found an insignificant impact of LMS usage on students' academic performance. This is because online learning can lead to stress among students and further result in a poor level of academic performance (Oducado & Estoque, 2021).

Also, researchers have a growing concern to investigate the relationship between LMS usage and academic performance (Avcı & Ergün, 2022). However, what is usually left is the inclusion of collaborative learning as a mediating variable, where it has been urged by Kaur et al. (2023) to include collaborative learning as a new intervening variable. Based on the above discussion, this study aims to examine the mediating effect of collaborative learning on the relationship between LMS usage and academic performance among students in a public university in Malaysia.

LITERATURE REVIEW

Theoretical Foundations

Constructivism, as a dominant educational term, has a significant effect on the process of learning and teaching. As emphasized by constructivism theory, students play a crucial role in active learning (Erbil, 2020). The constructivism theory is based on the viewpoints about collaborative learning and standpoints about constructivism developed by Bruner (1966). Piaget and Inhelder (1969) indicate that learners could acquire knowledge through tools. Constructivism theory discusses how interaction impacts collaborative learning and engagement. Besides, it is used to predict students' academic performance. It shows that interaction is an important factor in achieving collaborative learning and engagement. According to constructivism theory, information and communication technology is the proper platform for facilitating interaction (Bozanta & Mardikyan, 2017). Therefore, Social Networking Sites (SNS) have a significant effect on collaborative learning and student engagement (Al-Rahmi et al., 2018). Thus, this study applies constructivism theory to predict the impact of LMS usage on students' academic performance by investigating the mediating effect of collaborative learning (Qureshi et al., 2021).

LMS Usage and Academic Performance

Due to the introduction of LMS, students were not limited by traditional teaching methods such as face-to-face teaching, but they are enabled to conduct learning in a digital context with diverse web-based materials and online resources (Chen, 2018; Chicca & Shellenbarger, 2018; Oducado & Estoque, 2021). For instance, to investigate the role of web-based LMS in face-to-face classes and their effect on students' academic performance in the context of Lebanon, Asabe et al. (2021) found that class activities on a web-based LMS can significantly predict students' performance. In specific, the academic performance of students was found to be positively correlated with their frequency of using the LMS.

The depiction shown above was supported by the outcome of Zhang et al. (2020), who investigated the role of LMS in predicting the performance of students in the Tanzania context, and it was found that LMS can consolidate the academic achievement of students. This is because the LMS can facilitate peer communication, discussion efficiency among students, and exercises in their hybrid learning. Avcı and Ergün (2022) determined the role of students' LMS activities on academic performance and found a significant correlation between the level of participation in the LMS and academic performance. Therefore, the higher the level of usage of the LMS, the higher the level of the student's academic performance.

Based on the statement described by prior studies, the hypothesis for this research was proposed:

> **H1:** LMS usage has a positive relationship with students' academic performance.

LMS Usage and Collaborative Learning

The LMS offers online and offline discussion, practice questions, and examinations. LMS is considered an effective digital context for students' learning and it is developed for continuous study (Herayanti et al., 2017). An effective digital context for learning would promote students' critical thinking, interaction, cooperation, and creativity. This will further enhance their level of knowledge (Gunawan et al., 2019).

Alenazy et al. (2019) defines collaborative learning as a pedagogic approach wherein a group of students study together and exchange their resources and experience to complete academic tasks. SNS, such as Facebook, with proper utilization, can

facilitate the learning process through cooperation, communication, and information (Lai et al., 2024).

Based on prior studies, some researchers investigated the role of LMS on collaborative learning among students (e.g., El Mhouti & Erradi, 2018; Firman et al., 2021; Jagadish, 2016) and teachers (Medero & Albaladejo, 2020). On the other hand, numerous research studies have also explored how SNS affects students' collaborative learning (Alwreikat et al., 2021; Mahmud & Wong, 2018). For instance, Jagadish (2016) examined the effect of LMS used in the context of deaf students learning languages. According to the outcome, the use of LMS can help disabled students effectively learn the language and provide an adequate way to communicate. This finding was also supported by El Mhouti and Erradi (2018), who researched the influence of LMS on boosting collaborative learning, where students are motivated to engage in the use of collaboration services based on smart LMS. As for the teachers, the LMS can be utilized as a platform to track students' collaborative study, namely their group learning and productivity levels.

Firman et al. (2021) investigated online-based LMS. As suggested by the findings, there is a significant correlation between the use of online-based LMS and collaborative learning. Specifically, the use of the system contributes to the student's learning process by encouraging them to engage in learning activities and transforming the way students access information and share their knowledge. Besides, Medero and Albaladejo (2020) conducted research among university teachers in Spain. In the research, Wiki was discussed for enhancing collaborative learning. The findings of the study concluded that the Wiki, an LMS, supports collaborative learning and promotes the quality of education. In conclusion, the use of Wiki technologies was shown as an effective way for the student to improve their learning performance (Lin & Wang, 2024).

Based on the statement above, this study further hypothesizes that:

> **H2:** LMS usage is positively associated with collaborative learning.

Collaborative Learning and Students' Academic Performance

Regarding the impact of collaborative learning on academic performance, various empirical studies were conducted (Alalwan et al., 2019; Al-Rahmi et al., 2018; Manickam et al., 2020). Based on the literature carried out by the researchers, some of them determined the role of collaborative learning in the context of students' performance (Amadu et al., 2018; İlçin et al., 2018), which includes writing performance (Fanguy et al., 2023).

According to Al-Rahmi et al. (2018), collaborative learning results in a higher level of student performance and satisfaction. Specifically, the online social network enables students to organize different activities smoothly within their learning process and release pressures on their academic work. Also, students are enabled to promote their relationships with their peers in a more relaxed and enjoyable atmosphere. Thus, communication among students is important to improve their academic performance. This finding was supported by Amadu et al. (2018) and İlçin et al. (2018) who analyzed collaborative learning among university students. It was concluded that collaborative learning is a significant factor that predicts academic performance in the context of higher education (Lai et al., 2024).

Additionally, Al-Rahmi et al. (2018) and Dunbar et al. (2018) investigated the role of collaborative learning in determining the academic performance of university students. Based on the findings, collaborative learning exerts a positive association with academic performance. Thus, collaborative learning enriches the environment of students by improving the interaction and participation of students by promoting group discussions about their projects and works.

Arnaiz-Sánchez et al. (2020) developed a study on the enhancement of students' academic performance and academic success in the Spanish context. As demonstrated by the outcome of the study, collaborative learning, as the instructive method, would boost students' academic performance by improving language and mathematics-related subjects. As indicated by (Ansari & Khan, 2020; Manickam et al., 2020), there is a positive association between collaborative learning and academic performance.

According to the results of Cao and Tian (2020), who explored the association between collaborative learning and academic performance, collaborative learning has a core effect on academic performance among students. This is because collaborative learning can produce a sense of belonging to the team (Molinillo et al., 2018), encouraging students to learn and motivating them

to exchange opinions and knowledge (Al-Samarraie & Saeed, 2018). Kong (2021) reports that collaborative learning predicts a higher level of academic performance among students, which reflects that collaborative activities in students' learning process can effectively enhance students' capability in group study and creativity. In addition, a study by Kaur et al. (2023) affirms the mediating role of collaborative learning on the relationship between the UTAUT construct and behavioral intention to use WhatsApp for second language acquisition, which aligns with the study of Temirkhanov et al. (2024) on the inclusion of collaborative learning as mediator.

Hence, based on the discussion above, this study hypothesizes that:

> **H3:** Collaborative learning has a positive relationship with students' academic performance.

> **H4:** There is a mediating effect of collaborative learning on the relationship between the usage of LMS and academic performance.

METHODOLOGY

Research Approach

The present study is developed based on the positivism paradigm, which measures phenomena by analyzing data (Singh & Del Giudice, 2019). A quantitative, cross-sectional survey design is applied in this research. According to Aliaga and Gunderson (2002), quantitative research is considered the method applied to explain specific phenomena and issues by collecting data in the form of numbers and analyze data by applying mathematical procedures.

Sampling Procedure

This study applied purposive sampling (non-probability), which is also called judgment, selective, and subjective sampling (Sharma, 2017). It is used to choose the people who have the characteristics needed by the researcher (Campbell et al., 2020). Researchers need to know what they are researching and find selected people who are willing to provide their knowledge and experience information (Etikan et al., 2015). Therefore, this study used purposive sampling to solicit the responses from the respondents by incorporating screening questions such as, "Have you utilized a learning management platform before?" or "Have you utilized the LMS to do group discussion with peers/ friends and instructors?" as a way to filter invalid responses. Since LMS was utilized in the public university setting, most of the respondents have experience using it, and their responses were valid based on the criteria set.

Instruments

The questionnaire of the present research was divided into four sections. Section A is the demographic items of the respondents, which includes gender, age, nationality, race, and year of the study. Section B consists of the items on the usage of LMS adapted from Al-Rahmi et al. (2014), Qureshi et al. (2021), and Wandera et al. (2016). Section C is measured on the collaborative learning items adapted from Cao and Tian (2020), Qureshi et al. (2021), and Al-Rahmi et al. (2014). Lastly, in Section D, the items for academic performance were adapted from Al-Rahmi et al. (2015), Hidayanto and Setyady (2014), and Qureshi et al. (2021). The items from Sections B, C, and D were all measured based on a Likert-type scale, which ranged from 1 = strongly disagree to 5 = strongly agree. To avoid ambiguity and ensure the clarity of the questionnaire, a pilot test was carried out among 30 respondents from a private university. The criterion of Cronbach's alpha was applied in the research to assess the internal consistency of the constructs. Grounding on Hair et al. (2019), the value of Cronbach's alpha should surpass 0.7. As a result of the pilot test, all indicators' Cronbach's alpha is higher than that threshold, which can be perceived as acceptable.

Data Collection Procedures

The data were collected through online surveys via platforms, such as Facebook, WhatsApp, and email. Researchers sought permission to conduct the study through the introductory/cover letter of the instrument, and the participation of the respondents was voluntary. Researchers ensured data confidentiality and anonymity to the respondents. The data collection started on November 23, 2022. As of December 19, 2022, the target number of survey responses was reached.

Common Method Variance

Common Method Variance (CMV) is a common statistical issue in social science studies, which occurs when a cross-sectional survey is applied in empirical research (Chan et al., 2021b; Mohammed et al., 2021). In this research, to reduce the CMV, the single-factor analysis by Harman was adopted as a statistical remedy. According to Hair et al. (2014),

Table 1.
Demographic Distribution of the Respondents (N = 381)

Variables	Items	Frequency	%
Gender	Male	108	28.3
	Female	273	71.7
Age	20 and below	5	1.3
	20–25	363	95.3
	26-30	11	2.9
	35–40	1	0.3
	Older than 40	1	0.3
Nationality	International	44	11.5
	Malaysian	337	88.5
Race	Chinese	65	17.1
	Malay	275	72.2
	Indian	18	4.7
	Other	23	6
Year of Study	First	168	44.1
	Second	88	23.1
	Third	86	22.6
	Final Year	39	10.2

the value of the percentage of variance should not exceed the threshold of 50%. The percentage of variance for the current study is 48.104, which is lower than the threshold of 50%. Based on the statistical result of the single-factor analysis, it was indicated that CMV is not a crucial issue in this study.

RESULTS

Descriptive Analysis

Based on Table 1, this research involves a total of 381 samples. Most of the respondents were female (71.7%), and the rest 108 were male (28.3%). Regarding age, most participants were 20 to 25 years old, with a percentage of 95.3, which indicate the students are mostly young adults and technology savvy. For nationality, the respondents consist of 337 Malaysian students and 44 international students, represented by 88.5% and 11.5%, respectively. As shown in Table 1, the majority of the participants were students who were Malay, with the number being 275, which represents 72.2%. In terms of the year of study, nearly half of the respondents were in their first year, at 44.1%.

Measurement Model

According to Cronbach (1951), reliability can be assessed through Cronbach's alpha and Composite Reliability (CR). Both Cronbach's alpha and CR should be above the recommended threshold of 0.7. Additionally, as pointed out by Fornell and Larcker (1981), the Average Variance Extracted (AVE) value of all constructs should be above 0.5, while the factor loading is required to be higher than 0.6 (Byrne, 2016). The convergent validity can be confirmed acceptable if the value of CR and AVE are higher than the threshold of 0.7 and 0.5, respectively (Hair et al., 2013; Hair et al., 2019). The results shown in Table 2 indicate that the factor loading (> 0.6), and AVE of all items were all higher than 0.5, and the index of CR and Cronbach's alpha of all constructs were all above 0.7. In summary, the convergent validity of the constructs is established.

Table 2.
Convergent Validity

Variable(s)	Items	Loadings	Cronbach's alpha	CR	AVE
Academic Performance	AP1	0.770	0.937	0.948	0.669
	AP2	0.662			
	AP3	0.819			
	AP4	0.826			
	AP5	0.871			
	AP6	0.873			
	AP7	0.899			
	AP8	0.789			
	AP9	0.827			
Collaborative Learning	CL1	0.719	0.893	0.917	0.613
	CL2	0.801			
	CL3	0.825			
	CL4	0.847			
	CL5	0.690			
	CL6	0.735			
	CL7	0.845			
Usage of LMS	LMS1	0.668	0.802	0.859	0.505
	LMS2	0.788			
	LMS3	0.630			
	LMS4	0.781			
	LMS5	0.702			
	LMS6	0.680			

The Heterotrait-Monotrait (HTMT) ratio of correlations was considered as the criterion for estimating discriminant validity. According to Kline (2015), the value between constructs should not surpass 0.90. Table 3 demonstrates the result for discriminant validity, and it demonstrates that all the values between constructs were lower than the threshold of 0.90. Therefore, the discriminant validity was confirmed.

Table 3.
Discriminant Validity HTMT

	AP	CL	LMS
AP			
CL	0.851		
LMS	0.646	0.690	

Structural Model Assessment

As demonstrated in Table 4, usage of LMS (β = 0. 158, t = 3. 531, p < 0.01) is positively and significantly related to academic performance. This result was consistent with the study of Dunbar et al. (2018), who also confirms this postulation. Therefore, H1 was supported. Based on the LMS, students are allowed to conduct their academic studies by accessing the functions and services provided in the LMS. Hence, the interaction and information acquisition process of students can be improved. Finally, their academic grade can be enhanced through engagement in the platform.

Subsequently, the usage of LMS also significantly impacted collaborative learning (β = 0.592, t = 14. 677, p < 0.01), which supports the findings of the previous literature. For instance, Abrahim et al. (2018) found that the use of LMS significantly leads to collaborative learning. Udenze and Oshionebo (2020) also found that using information technology is significantly related to collaborative learning. This is because students are allowed to interact with their lecturers and instructors as well as acquire course-related information and engage in class activities on LMS, and their collaboration was strengthened.

In addition, collaborative learning (β = 0.692, t = 16. 099, p < 0.01) positively and significantly impacts academic performance, which supports the studies of Kong (2021) and Anshori and Suwidiyanti (2020). This is because collaborative learning can facilitate the learning process of students, such as information exchange and information sharing. In that, collaborative learning was confirmed to affect academic performance significantly.

The result of the mediation analysis is displayed in Table 5. It was shown that there is a partial mediating effect of collaborative learning between the usage of LMS and academic performance, with (β = 0.409, t = 10.576, CI = 0.334-0.486). This result is congruent with the results of Cao and Tian (2020) and Kaur et

Table 4.
Hypothesis Testing for Direct Effects

Path	Std. Beta	Std. error	t-value	P	LLCI (5%)	ULCI (95%)	D	R2	f2	VIF
H1: LMS -> AP	0.158	0.045	3.531**	0.000	0.084	0.231	S	0.633	0.044	1.539
H2: LMS -> CL	0.592	0.040	14.677**	0.000	0.515	0.651	S	0.350	0.539	1.000
H3: CL -> AP	0.692	0.043	16.099**	0.000	0.617	0.758	S		0.846	1.539

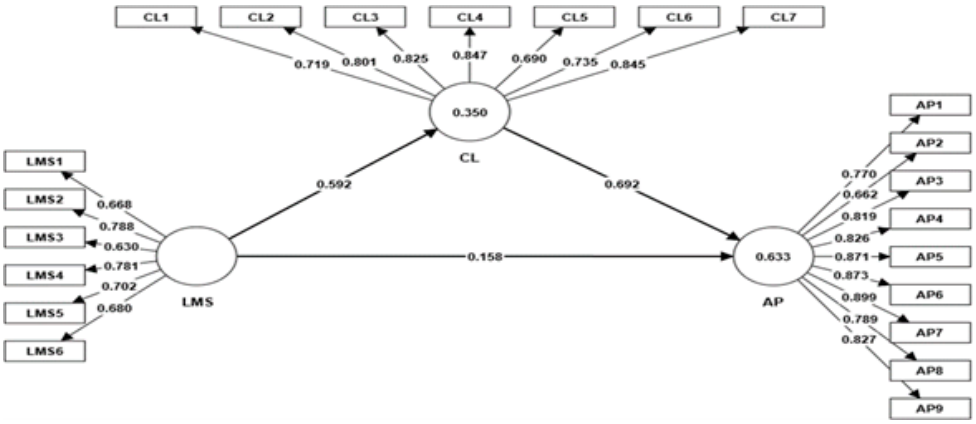
Note. LMS = LMS Usage; AP = Academic Performance, CL = Collaborative Learning; LLCI = Lower Limit Confidence Interval; ULCI = Upper Level Confidence Interval; S = Supported; ** p < 0.01; 1-tailed test

Table 5.
Indirect Effect

Path	Std Beta	Std. error	t-value	P	LLCI (2.5%)	ULCI (97.5%)	D
H4: LMS -> CL -> AP	0.409	0.039	10.576**	0.000	0.334	0.486	S

Note. LMS = LMS Usage; AP = Academic Performance, CL = Collaborative Learning; LLCI = Lower Limit Confidence Interval; ULCI = Upper Level Confidence Interval; S = Supported; ** p < 0.01; 2-tailed test

Figure 1.
Structural Model



al. (2023), which affirms a mediating effect of collaborative learning and social media use and academic performance and learning of second languages. Considering the viewpoint of previous research, it was confirmed that the relationship between the use of LMS and academic performance was significantly intervened by collaborative learning as a mediator.

Table 6.
PLS Predict

	Q^2predict	PLS-SEM_ RMSE	LM_ RMSE	PLS-SEM -LM	Interpretation
AP1	0.170	0.760	0.768	-0.008	
AP2	0.117	0.777	0.777	0.000	
AP3	0.229	0.889	0.900	-0.011	
AP4	0.158	0.757	0.763	-0.006	Moderate
AP5	0.249	0.763	0.767	-0.004	
AP6	0.233	0.773	0.777	-0.004	
AP7	0.273	0.794	0.801	-0.007	
AP8	0.201	0.773	0.784	-0.011	
AP9	0.240	0.812	0.822	-0.010	
CL1	0.161	1.144	1.149	-0.005	
CL2	0.262	0.859	0.853	0.006	
CL3	0.243	0.938	0.945	-0.007	Moderate
CL4	0.249	1.023	1.032	-0.009	
CL5	0.135	0.771	0.776	-0.005	
CL6	0.163	0.804	0.807	-0.003	
CL7	0.252	0.888	0.902	-0.014	

Additionally, the present study also applied PLS-predict assessment (Shmueli et al., 2019) to analyze the predictive relevance of the model to the out-of-sample prediction. As shown in Table 6, there is moderate predictive power for collaborative learning and academic performance.

CONCLUSION

This research shows that collaborative learning is a significant mediator which mediates the relationship between the usage of LMS and academic performance among students in a Malaysian public university.

Theoretical Contribution

As for the theoretical implications of the study, the result of this research brings about theoretical evidence for investigating the influence of the LMS on students' academic performance. The research contributes to the constructivism theory and the information technology scholarship in teaching and learning in the Malaysian context. Linking with the literature gaps of previous research, the indirect relationship between the usage of technology and academic performance still needs further investigation due to the digitalization of technology in higher education. Hence, the inclusion of collaborative learning as a mediator sheds light and contributes to the existing literature. Also, according to the findings of the study, the constructivism theory is confirmed as an adequate underlying model to explore the academic performance of university students, and the investigation of collaborative learning as a mediator may add to the existing literature on ICT technologies in which limited researchers studied the indirect effect of LMS usage on academic performance through collaborative learning. Lastly, our result indicates

that collaborative learning among students is conducted based on their actual use of LMS, and LMS platforms are appropriate for improving interactions among students in their learning process. The results extend the lens of the constructivism theory in an educational context by examining the benefits of LMS use and interactions with students' learning outcomes. By applying LMS systems to students' learning, their level of knowledge can be improved through their interactions with others for educational purposes. Subsequently, their academic performance can be enhanced.

Practical Implication

In terms of practical implications of this study, the findings provide practical guidelines to the university. The empirical evidence of the study encourages the university management to promote a sustainable LMS among students, enabling students to conduct their studies collaboratively. As such, students' learning outcomes can be indirectly and significantly influenced by the improvement of the LMS system. To improve the implementation of the LMS systems in university contexts, some strategies can be taken into consideration by universities and academic staff.

Firstly, universities are recommended to provide students and lecturers with instructive training. This can help lecturers and students understand better the usage of LMS and its interactive features, which can encourage them to collaborate with others more effectively. Secondly, lecturers are suggested to assign LMS-based assignments and motivate students to collaborate in completing assignments. Hence, the effectiveness of teamwork among students can be improved. Lastly, as a strategy to enhance student engagement in LMS-based collaborative learning, service providers should pay attention to service quality by constructing student-centered LMS platforms. Service providers are advised to listen to students' feedback and optimize the platform's collaborative features, such as gamification and videos.

In addition, the students can benefit from the research outcome, as the outcome revealed a positive direct relationship between the usage of LMS and academic performance. Based on the evidence of the study, students are encouraged to improve their frequency of engaging in the LMS system, especially enhancing their frequency of information-seeking, knowledge exchange, and student–instructor interactions. By Introducing LMS in their studies process, the teaching and learning process can be enhanced through the use of the system.

Limitations and Suggestions for Future Research

This research poses some limitations. Firstly, the research was conducted in one public university in Malaysia, and the undergraduates were recruited as participants in the survey research. Thus, the results could not be generalized to reflect the usage of LMS usage in other Malaysian public universities. Consequently, the research phenomenon can be extended by future researchers. For instance, future studies can propose research to be done on other public or private higher education institutions in Malaysia or Asian countries. Also, the respondents for the research can include postgraduate students to obtain a different outcome in terms of their perception of LMS usage.

Additionally, the current study used a cross-sectional design, which can only capture a snapshot at one point in time. Thus, it cannot establish causality between the variables. Future studies can incorporate longitudinal studies, mixed methods, and control variables as remedies to compensate for the limitations of cross-sectional design.

Furthermore, collaborative learning was studied as the mediator between the use of LMS and academic performance. However, the mediating role of other variables in this relationship has not been discovered. To narrow this literature gap, future studies are recommended to examine the other variables, such as students' engagement (Chan & Dai, 2023; Youngren, 2021), students' academic motivation (Ferreira et al., 2023; Teo et al., 2023), perceived instructor/teacher support (Descals-Tomás et al., 2021), group dynamics (Shanmuganeethi et al., 2020), and test the moderating effects of demographic variables to make the framework more robust.

Lastly, the results indicate that collaborative learning benefits students' academic performance, which implies that students' interactions with others are important to improving their understanding and knowledge regarding their courses. However, this study does not explore whether and how the quality of their interaction, individual learning style (Oliveira et al., 2023), and study habits (Muhammad et al., 2023) affect academic performance. In that, we encourage future researchers to

narrow these voids by examining whether and how communication quality and the mentioned variables can affect their learning, and this will contribute to the educational technology scholarship.

DECLARATIONS OF INTEREST

The author declares no competing interest.

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APPENDIX

Constructs	Items	Sources
LMS Usage	I submit class attendance through LMS. I engage in class activities through LMS. I use the chat function in LMS to discuss topics learned in the class. I use LMS to engage in forums related to the courses. I use LMS to access quizzes (midterm and final exams). I use URLs in LMS to access pedagogical websites and class links.	Al-Rahmi et al., 2014; Qureshi et al., 2021; Wandera et al., 2016
Collaborative Learning	The collaborative learning experience in the LMS environment is better than in a face-to-face learning environment. I actively participate in collaborative learning. Using LMS to facilitate interaction with peers. Using LMS allows me to discuss with lecturers. LMS allows the access of information. I was able to develop new skills and knowledge from learning materials provided by instructors. I felt that using LMS for collaborative learning in my group was effective.	Cao & Tian, 2020; Qureshi et al., 2021; Al-Rahmi et al., 2014
Academic Performance	LMS utilization helps the process of task schedule planning to become easier. LMS utilization helps the process of assignment submission to become easier. LMS utilization helps the process of interaction with instructors to become easier. LMS utilization helps the process of information acquisition to become easier. The use of LMS has improved my comprehension of the concepts studied. The use of LMS has led to a better learning experience. The use of LMS has allowed me to better understand the concepts. I can apply the material on LMS for academics. Based on LMS, I learned a lot from the project work.	Al-Rahmi et al., 2015; Hidayanto & Setyady, 2014; Qureshi et al., 2021