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THE CONSTRUCTIVIST LEARNING THEORY: EXPLORING KEY TECHNOLOGICAL ADVANCEMENTS IN LEARNING MANAGEMENT SYSTEMS

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Abstract:

The Constructivist Learning Theory emphasizes learners actively constructing knowledge through experiences and reflection, significantly influencing Learning Management Systems (LMS) design and development, which are pivotal in modern education. This article carefully examines the progress of technology in LMS while looking at it through the perspective of Constructivist Learning Theory, utilizing the PRISMA framework. The review focuses on innovations such as artificial intelligence (AI), machine learning (ML), gamification, mobile learning, learning analytics, and collaborative tools. These technologies have transformed LMS into interactive, personalized, and efficient platforms supporting active learning and knowledge construction. The paper examines how these advancements align with constructivist principles, enhancing student engagement and learning outcomes. Additionally, it addresses the challenges and limitations of implementing these advancements and suggests potential future research directions.

Keywords:

Artificial Intelligence (AI), Constructivist Learning Theory (CLT), Learning Management Systems (LMS), Modern Education, Review Paper, Technological Advancements

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Introduction

In recent years, the educational landscape has been significantly transformed by the integration of technology, particularly through Learning Management Systems (LMS). These platforms are now crucial tools for distributing, overseeing, and evaluating educational material across both traditional classrooms and virtual learning settings. The Constructivist Learning Theory is fundamental in designing and implementing effective LMS, as it suggests that learners build their own knowledge through experiences and reflection (Pardjono, 2016).

The constructivist approach has gained renewed importance as technological advancements have enabled more interactive, personalized, and immersive learning experiences. Technologies such as artificial intelligence (AI) and machine learning (ML) have revolutionized LMS by providing adaptive learning paths and real-time feedback, which cater to individual learner needs and promote deeper engagement (Kharroubi & ElMediouni, 2024). Such as gamification, an important advancement, integrates game elements into learning tasks to boost motivation and engagement, in harmony with constructivist principles that aim to make learning exciting and connected to real-world situations (Brown, 2023).

Moreover, the proliferation of mobile learning (m-learning) has further extended the reach and accessibility of LMS, allowing learners to engage with educational content anytime and anywhere. This flexibility supports the constructivist notion of learning as a continuous, context-dependent process (Feist, 2022). Cloud computing has also played a pivotal role in the evolution of LMS, offering scalable and cost-effective solutions that facilitate collaborative learning and resource sharing (Khan & Salah, 2020).

Virtual and augmented reality (VR/AR) technologies have introduced immersive learning environments that enable learners to explore and interact with complex concepts in a simulated setting. These advancements align with the constructivist emphasis on experiential learning and have shown significant potential in fields such as medicine and engineering (Marougkas et al., 2023). Learning analytics, powered by sophisticated data analysis tools, provides insights into learner behavior and performance, allowing educators to tailor instructional strategies and improve educational outcomes (Caspari-Sadeghi, 2023).

Despite these advancements, the implementation of such technologies in LMS is not without challenges. Issues such as data privacy, the digital divide, and resistance to technological change must be addressed to fully realize the potential of these innovations (Mojidi, 2023). This paper aims to explore the key technological advancements in LMS through the lens of Constructivist Learning Theory, highlighting how these innovations support active learning and knowledge construction, while also discussing the challenges and future directions in this evolving field. As mentioned previously, developing research queries are outlined below.

1. RQ1 - How do these technologies impact learner engagement and knowledge construction?
2. RQ2 - What specific Artificial Intelligence (AI) and Machine Learning (ML) applications are used in LMS to facilitate personalized and adaptive learning experiences?

Literature Review

Constructivist Learning Theory emphasizes the importance of active, experiential, and personalized learning. It posits that learners construct their own understanding and knowledge through experiences and reflecting on those experiences. In the modern educational context,

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this theory is increasingly relevant as it encourages students to engage actively with the material, fostering deeper understanding and retention of knowledge. LMS powered by AI can evaluate student data to develop customized learning plans that address individual requirements, supporting the Constructivist Learning theory that highlights personalized and hands-on learning (Angraini et al., 2024). Machine learning algorithms forecast student results and provide timely interventions, further endorsing the constructivist method through enabling ongoing feedback and adaptation (Vijayakumar Bharathi & Pande, 2024). Artificial Intelligence (AI) and Machine Learning (ML) have significantly transformed Learning Management Systems (LMS) by providing personalized learning experiences and enhancing administrative efficiency.

The rapid advancement of technology has significantly transformed Learning Management Systems (LMS), providing tools that support the principles of Constructivist Learning Theory. These technologies make personalized, adaptive, and interactive learning experiences easier, leading to increased active engagement and knowledge construction. AI and ML have significantly transformed LMS by enabling personalized learning paths and adaptive learning experiences. AI applications, such as intelligent tutoring systems, automated grading, and personalized content delivery, tailor educational experiences to individual learner needs (Vijayakumar Bharathi & Pande, 2024). Machine learning algorithms, through predictive analytics and learning pattern recognition, help identify student needs and provide timely interventions (Al-Shabandar et al., 2019). These technologies affect learner engagement through providing immediate feedback and motivation, while also boosting knowledge construction with self-paced and ongoing assessment. However, Sophisticated LMS capabilities that support constructivist learning can be adjusted and offered to various educational institutions, potentially reducing the excellence of personalized learning opportunities (Asabere et al., 2021).

Gamification incorporates elements of game design, such as badges, leaderboards, and point systems, in educational settings to enhance motivation and engagement. In the learning management system, gamification greatly increases learner involvement and participation by creating a more interactive and enjoyable learning experience (Sun & Xu, 2024). These elements align well with constructivist principles, as they foster intrinsic motivation and active involvement, thereby enhancing learning outcomes through engaging and interactive activities. Opponents of gamification argue that its effectiveness could decrease as the novelty fades, and it may not be compatible with every learning style (Al-Shabandar et al., 2019).

Mobile learning makes use of mobile devices to offer educational content, allowing learners flexibility and convenient access. This mode of learning supports continuous and context-dependent learning, allowing students to engage with educational materials anytime and anywhere (Johnson, 2022). Mobile learning aligns with constructivist principles by accommodating diverse learning styles and environments, thereby increasing learner engagement and supporting personalized knowledge construction. Nevertheless, challenges such as screen size limitations and potential distractions need to be addressed to maximize its effectiveness (Johnson, 2022). Cloud computing has revolutionized LMS by providing scalable, flexible, and cost-effective solutions. Cloud-based LMS platforms facilitate seamless updates, enhanced data security, and improved collaborative capabilities, creating resource-rich learning environments (Nicolas et al., 2024). These platforms support constructivist principles by enabling easy access to learning materials and collaborative tools, thus promoting

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group work and peer learning, which are essential for active engagement and collective knowledge construction. Critics point out that dependency on cloud services may lead to issues related to data privacy and security, which need careful management (Gill et al., 2019). Collaborative tools within LMS, such as discussion forums, real-time collaboration tools, and peer review systems, facilitate social learning and knowledge sharing.

These tools support the constructivist view that learning is a social process, enhancing student interaction and collective knowledge construction (Olabanji et al., 2024). Proper utilization of these resources encourages a feeling of togetherness and collaborative studying, which are essential for meaningful academic experiences. However, challenges such as unequal participation and managing group dynamics need to be addressed to ensure their effectiveness (Kimmerle et al., 2015). Despite making great progress, there are difficulties when trying to incorporate these technologies into LMS, including issues like data privacy, the digital divide, and resistance to change. Addressing these challenges requires strategies that ensure equitable access to technology and protect student data (Donelan & Kear, 2024). Future research should focus on overcoming these obstacles and exploring new technologies that further integrate constructivist principles with LMS.

Methodology

The methodology section outlines the approach taken to conduct this review of technological advancements in Learning Management Systems (LMS) through systematic literature review (SLR) and combine with systematic reviews and meta-analyses. Wong & Matore (2020) explained that a systematic literature review (SLR) involves examining past studies to address research questions by identifying, analyzing, formulating, and critically evaluating the materials under study. Moher et al.'s Donelan & Kear (2024) highlight that PRISMA guideline flow diagram was utilized to choose pertinent items for systematic reviews and meta-analyses. PRISMA is a reliable systematic review guideline as its thorough and detailed method includes a substantial amount of data. Purposely, The SLR and PRISMA approach ensures a comprehensive and unbiased collection of relevant studies, enabling a thorough analysis of the impact of these technologies on learner engagement and knowledge construction.

Furthermore, Page et al. (2021) highlighted the benefits of utilizing the PRISMA approach in social science, as it ensures data comes from reputable sources and is acknowledged by researchers, aiding in addressing research limitations through keywords. Additionally, this method saves authors time by reassuring them of the sufficiency of their literature review. Verastegui et al., (2023) also concurred that researchers can use the PRISMA method to identify the required studies based on their research inquiries. The PRISMA flowchart consists of four steps to help researchers identify which study is appropriate for their needs, starting with the stages of identification, screening, eligibility, and inclusion (Page et al., 2021).

Article Search Strategy

The search for articles on SLR relies on two academic databases, namely Web of Science (WoS) and Scopus. These databases were selected for the study due to their comprehensive coverage of journal articles from various sources. Rethlefsen et al. (2021) mentioned that the choice of both primary resources involves utilizing "search engines," which aid in finding relevant and high-quality studies for systematic investigations. The exploration was carried out with the keyword phrases "E Learning" and "Learning Management System" in WoS and Scopus. Table 1 displays the keywords utilized during the selection of articles.

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Table 1: Article Search for SLR

Data Base	Keywords
Web of Science	TI= "E Learning" and "Learning Management System"
Scopus	TITLE-ABS-KEY ("E Learning" and "Learning Management System")

Article Selections Criteria

In order to get precise and relevant articles that align with the research questions, multiple measures have been implemented to screen all the articles gathered as depicted in Figure 1. The first screening process is based on several acceptance and rejection criteria, respectively. Setting criteria involves five steps, which are considering the publication year, type of reference material, language, methodology, and field of study for journal articles.

The initial step involves focusing on the publication dates of the articles, specifically those within the past decade from 2014 to 2024. One key factor behind choosing this setting is the fact that the practice of E learning is considered fairly recent in the education sector, which is why a 10-year limit is applied to searches. The second step entails the removal of articles having the same findings or recurrent articles, even from different databases. In addition, only journal articles were selected, while SLR articles, books, proceedings, theses, and conferences were excluded from this study. In the third step, all the selected articles are in English, while in the fourth step, the analysis was carried out through a full and in-depth reading of the selected articles. The methodology chosen in each journal article includes quantitative, qualitative, and mixed methods. In the fifth step, the areas of study selected include the implementation of the Six Sigma approach at school and higher education levels. Table 2 shows the criteria for the acceptance and rejection of journal articles for this study.

Table 2: Article Acceptance and Rejection Criteria

Criterion	Acceptance	Rejection
Year of publication	Publications from 2014-2024	Publications before the year 2012
Type of reference material	Journal articles	Theses, proceedings, books, and conferences
Language	English	Indonesian, Malay, and others
Theory	Constructivist Learning Theory	Other
Methodology	Quantitative, qualitative, mixed method.	Systematic literature review
Field of study	Education	Others

Article Selections Process

In this study, both the WoS and Scopus databases were utilized, along with manual searching, to locate, identify, and assess the appropriateness of articles to address the research inquiries. (Gusenbauer & Haddaway, 2020). proposed a manual selection process for articles using the method of "handpicking". Because Google is a trustworthy search engine with resources on E learning, it was utilized in this investigation.

The heading of every article, summary, and main text were examined to confirm that the article is suitable and aligns with the predetermined criteria. After that, the chosen articles were screened before moving on to the next stage. Figure 1 displays the PRISMA flow chart (Liu,

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2024), outlining the steps involved in searching and screening articles as analytical data. In total, 3,135 articles were found in both databases combined.

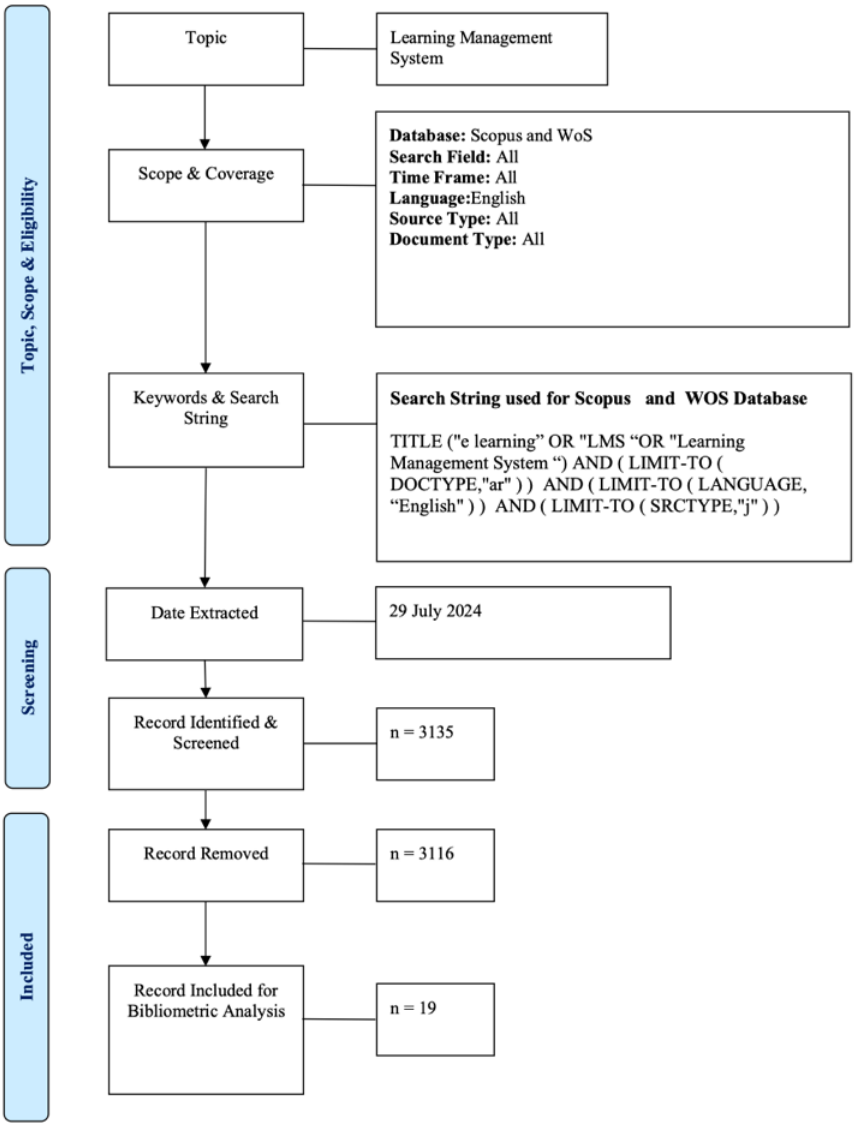

Figure 1: **Screening Model for Study**

Data Collection and Analysis Process

Following the review of each article, only 19 articles out of the initial 77 were chosen for this study. Furthermore, the examined articles have been subjected to a procedure of article approval and article denial based on the set criteria. Table 3 displays a selection of journal articles including authors, publication years, country of origin, and research titles. Data representations like bar graphs and tables are used to present the analysis results.

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Table 3: List of Articles Analyzed in SLR

No	Author	Year	Country	Article Title
1	Autsadee Y.; Jeevan J.; Mohd Salleh N.H.B.; Othman M.R.B.[20]	2023	Malaysia	Digital tools and challenges in human resource development and its potential within the maritime sector through bibliometric analysis
2	Odame J.; Yalley C.E. [16]	2023	Ghana	Flexibility and Usability: Focal Point of Graduate Students' Knowledge Level of The Features of SAKAI Learning Management System
3	Al Mansoori A.; Ali S.; Pasha S.A.; Alghizzawi M.; Elareshi M.; Ziani A.-D.; Alsridi H.	2021	United Arab Emirates	Technology Enhanced Learning Through Learning Management System and Virtual Reality Googles: A Critical Review
4	Asabere N.Y.; Agyiri J.; Tenkorang R.; Darkwah A.	2021	Ghana	Learning Management System (LMS) Development for Higher Technical Education in Ghana
5	Raju R.; Bhat S.; Bhat S.; D'Souza R.; Singh A.B.	2021	India	Effective usage of gamification techniques to boost student engagement
6	Kant N.; Prasad K.D.; Anjali K.[18]	2021	India	Selecting an appropriate learning management system in open and distance learning: a strategic approach
7	Al-Fraihat, D., Joy, M., & Sinclair, J. (2020).[18]	2020	UK	Evaluating E-learning Systems Success: An Empirical Study
8	Asamoah M.K.	2021	Ghana	Reflections and refractions on Sakai/Moodle learning management system in developing countries: A case of Ghanaian universities' demand and supply perspective analyses
9	Senin M.S.; Ali S.; Hau T.C.; Jamaluddin N.S.; Rahman S.A.	2023	Malaysia	Relationship between Self–Efficacy and Student Psychology in Blended Learning Courses

Result And Discussions

First Research Questions: How Do These Technologies Impact Learner Engagement And Knowledge Construction?

Table 3 depicts the trends in the publication of learning management systems (LMS) in the field of education across various countries globally. According to the chart, nine countries have released articles about the use of learning management systems (LMS) in the education sector.

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Ghana stood out as the top country, providing three articles at 33.33% each, with United Arab Emirates and Malaysia following closely at 13.33%. Additionally, Malaysia, India, United Kingdom, and United Arab Emirates each contributed 6.67% of the articles.

The results also indicated that there is limited research on the effects of learning management systems (LMS) technologies on learner engagement and knowledge in Malaysia. The findings indicated that Ghana was the leading country in publishing e-learning articles in the education field (Asabere et al., 2021; Johnson, 2020; Nicolas et al., 2024). Asabere et al., 2021 reported that a large number of the 200 lecturers and 16 students surveyed at ATU are ready to adopt technology and the newly created LMS at the institution. The analysis of the impact of automated performance assessment on student academic performance indicates that learners achieve better learning outcomes through advanced education methods utilizing various forms of learning management. Rewrite the text using the same language and maintaining the word count [30].

Moreover, India provided two articles for publication, labeled as (Hussain et al., 2019; Tuli et al., 2019). Malaysia also provided two articles from the same writer for publication (Olabanji et al., 2024; Kimmerle et al., 2024). Arafeh's initial research centered on enhancing school administration, with the second study focusing on boosting student academic achievement through the utilization of learning management systems (LMS). In contrast, some countries like the United Kingdom (Gill et al., 2019) and the United Arab Emirates (Eden et al., 2024) have only released one article. Table 3 illustrates the trends in the publication year of articles on learning management systems (LMS) in the field of education. Clearly, few articles on learning management systems (LMS) in education were published between 2014 and 2024. In fact, only a total of 9 articles were published during this time frame, with a consistent number of publications being released. It is worth noting that there was a rise in the number of related articles published in 2020, but there were no studies on e-learning in education in 2017.

Second Research Questions: What Specific AI And ML Applications Are Used In LMS To Facilitate Personalized And Adaptive Learning Experiences.

The analysis is presented in Table 4. Artificial intelligence (AI) and machine learning (ML) applications in learning management systems (LMS) are transforming personalized and adaptive learning experiences and the creation of customized learning paths by analyzing large amounts of data on individual student behaviors, preferences, and performance. The examination of the systematic review of literature reveals that three articles, 15% of them, conducted research on learning management systems (LMS) in educational institutions (Sun & Xu 2024; Gill et al., 2019) and one in higher education Donelan & Kear (2024). At the same time, the other 6 articles focus on 95% of research on learning management systems (LMS) in the field of education. Earlier studies (Sun & Xu 2024; Gill et al., 2019) indicated that incorporating learning management systems (LMS) into technical education can enhance student academic quality and success levels. Likewise, Olabanji et al., (2024) also emphasized the necessity of robust quality assessment methods for the enhancement of education through learning management systems (LMS).

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Table 4: The Analysis Of Artificial Intelligence (AI) And Machine Learning (ML) Applications Used In LMS To Facilitate Personalized And Adaptive Learning Experienced

Aspect	AI/ML Application	Impact on Learning Management Systems (LMS)	References
Personalized Learning Paths	AI algorithms evaluate student behaviors, preferences, and performance to create custom learning journeys.	Tailored content and resources based on individual student needs, improving engagement and retention.	(Sun & Xu 2024), (Gill et al., 2019), Olabanji et al., (2024), Donelan & Kear (2024), Liu, C. (2024), Bernius et al., (2022)
Adaptive Learning Systems	Machine learning models adapt learning materials in real-time based on student performance.	Immediate adjustment of learning difficulty and content to better suit students' current skill level.	(Gill et al., 2019), Donelan & Kear (2024), (Eden et al., 2024)
Predictive Analytics	AI analyzes engagement and performance data. to predict student outcomes and identify those at risk.	Enables early intervention for struggling students, improving academic success rates and retention.	Olabanji et al., (2024),Bernius et al., (2022), Albérico & Joana (2022)
Automated Feedback and Assessments	Machine learning provides instant grading and feedback, and tailors assessments to student performance	Faster feedback cycles, enhanced student understanding, and improved assessment personalization.	Johnson, S. (2020), (Gill et al., 2019), Donelan & Kear (2024)

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Natural Language Processing (NLP)	AI tools analyze written content and provide feedback on grammar, structure, and content quality.	Improves writing skills and critical thinking through detailed feedback on written assignments.	Olabanji et al., (2024), Bernius et al., (2022)
Learning Behavior Analytics	AI tracks student interaction with course materials, such as quizzes, videos, and forums.	Insights into student engagement patterns enable instructors to refine content delivery and improve outcomes.	(Sun & Xu 2024), (Gill et al., 2019), Donelan & Kear (2024), Bernius et al., (2022), Albérico & Joana (2022)
Quality Assessment Methods	AI-powered tools assess the quality of educational processes and suggest improvements	Continuous improvement of educational standards and management processes in educational institutions.	(Sun & Xu 2024), (Gill et al., 2019), Olabanji et al., (2024), Bernius et al., (2022), Albérico & Joana (2022)

The results of the analysis on the nine selected papers showed that the learning management systems (LMS) approach to education prioritizes student development, teaching and learning, and management equally. Five different publications cover different aspects of learning management systems (LMS) in total, including (Sun & Xu 2024; Johnson, S. 2020; Gill et al., 2019; Donelan & Kear 2024). The results of the analysis showed that Ghana's technical education has effectively addressed the issues identified by the learning management systems (LMS) approach. Furthermore, Bernius et al., (2022) illustrated how the university's leadership has gained advantages from utilizing the learning management systems (LMS) method, pinpointing potential areas for enhancement and elevating the quality of administration. Similarly, Albérico & Joana (2022) also stated that the main purpose of learning management systems (LMS) is to enhance a procedure to achieve favorable and optimal results. Therefore, utilizing learning management systems (LMS) in schools is recommended to improve the quality of teaching from educators.

Conclusion

According to SLR, hardly many publications about learning management systems (LMS) in education have been published over a ten-year period from 2014 to 2024, particularly in Malaysia. It is noteworthy to mention that there is a dearth of research on learning management systems (LMS) in Malaysian education, despite their widespread use. When it comes to the publication of e-learning papers in the realm of education, Ghana leads other nations in this

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regard. Previous research has also demonstrated that sampling tendencies are more common in educational settings. Three areas are the focus of the learning management systems (LMS) approach in education: student development, teaching and learning, and management. This analysis unequivocally demonstrates that there are still insufficient studies on the application of the e-learning strategy to assess Malaysian teachers' instructional quality. Indeed, the studies that have already been written that use the learning management systems (LMS) approach are only able to gauge how much lecturers' quality of instruction has improved. The results of the SLR can support the notion of utilizing more efficient methods to enhance the potential of online learning in order to raise teacher quality, especially in the area of education. Additionally, the growth of students is positively impacted by the evident theoretical contribution to the learning management systems (LMS) concept's development in the educational environment as opposed to the prior one, which was dominated by engineering. Therefore, it is advised that more study be done in the future so that the pertinent parties can examine the efficacy of online learning in the field of education, especially in the context of Malaysia.

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