





RESEARCH ARTICLE

Physical Education Learning Management System for Senior High Schools

Sapto ADI¹, Abi Fajar FATHONI^{*2}, Ndaru Kukuh MASGUMELAR³ and Nur Azlina Mohamed MOKMIN⁴

¹Universitas Negeri Malang, Faculty of Sport Science, Department of Sports Science, Malang / Indonesia

²Universitas Negeri Malang, Faculty of Sport Science, Department of Physical Education, Health and Recreation, Malang / Indonesia

³State Senior High School 1 Bantur, Malang / Indonesia

⁴Centre for Instructional Technology and Multimedia, Universiti Sains Malaysia, Penang / Malaysia

*Corresponding author: fajarfathoniabi@um.ac.id

Abstract

This study endeavors to evaluate the benefits and contributions of the Learning Management System (LMS) employed in Senior High School-level Physical Education instruction. Employing a qualitative methodology, the research employs systematic content analysis in conjunction with numerical data, visually depicting user responses to the utilization of the Learning Management System. The study encompassed 130 high school students from diverse regions in East Java, specifically: (1) the northern region (Surabaya), (2) the central region (Malang), (3) the southern region (Blitar), (4) the eastern region (Banyuwangi), and (5) the western region (Madiun). The findings reveal that 85.72% of participants expressed a positive perception of the overall supportive aspects of the Learning Management System. In conclusion, this research contends that the Learning Management System imparts benefits and makes a substantial contribution to the implementation of learning in Physical Education at the Senior High School level.

Keywords

Learning Management System, Learning Physical Education, High School

INTRODUCTION

The evolution of science and technology has revolutionized the landscape of learning materials and teaching methodologies. The learning process now encompasses the intricate connection between various components such as students, educators, media, learning materials, and the environment. Information technology, by enabling swift and high-quality work, has significantly boosted productivity and performance. In comparison to traditional face-to-face learning, technology-driven material delivery allows students to delve deeper into their studies (Burrows et al., 2021; See et al.,

2022; Singh & Hiran, 2022; von Maltitz & van der Lingen, 2022). Globalization in education is propelled by media, playing a pivotal role in achieving educational goals and improving overall education quality (Goad et al., 2019; Mokmin & Ridzuan, 2022). One emerging trend is the rise of learning management systems, especially with the widespread adoption of distance learning (Lwande et al., 2021; Maslov et al., 2021).

A learning management system, whether server-based or internet network-based (cloud), operates as software with a database interface containing user, learning, and content information (Khan et al., 2019; Santiago et al., 2020). This

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system manages the interaction in the learning process through information and communication technology via a website. The requirement for internet access highlights the global nature of these systems, emphasizing that a computer serves as the foundational tool for their development and utilization (Başaran & Mohammed, 2020; Şahin & Yurdugül, 2022). In the realm of national education, information and communication technology plays seven essential roles, spanning from serving as a repository of knowledge to acting as educational infrastructure (Cueva & Inga, 2022; De Oliveira et al., 2023).

The advent of electronic learning further transforms the dynamics of teacher-student interactions, breaking the constraints of time and space. The learning management system becomes a knowledge terminal that integrates with various sources, including libraries, facilitating a continuous learning experience beyond traditional classroom boundaries (Qasim & Abdulazeen, 2021; Suartama et al., 2021). Selecting a learning method becomes crucial in the context of learning management systems, with different modes such as full electronic, distance, and blended learning gaining prominence (Balkaya & Akkucuk, 2021; Kim et al., 2021). Electronic learning, particularly in higher education, involves self-directed learning, a concept slowly gaining acceptance in primary and secondary education levels in Indonesia (Goh & Yang, 2021; Saputro & Susilowati, 2019).

Moving to the realm of physical education, the focus extends beyond physical training, emphasizing a broader educational perspective aimed at developing all potential aspects of individuals (Barkova, 2020; Li & Wang, 2022). Physical education serves as a formal channel for cultivating knowledge and values through physical activity, striving to train and develop all potential aspects of individuals (Abdul Khalik, 2021; Kubiyeva et al., 2020; Lamb & King, 2021; Qu, 2022). Its scope extends to individuals of all age groups, fostering physical fitness, a regular engagement in physical activities, and an appreciation for a healthy lifestyle (Pereira et al., 2021; Rahim et al., 2021).

Evidence suggests widespread favorability for physical education among students, with the primary goal being the cultivation of a lifestyle marked by regular physical activity engagement (Jeong & So, 2020; Nugraha et al., 2022).

Adolescence, a critical period encompassing mental, emotional, social, and physical growth, exhibits distinct characteristics, including rapid physical development, enhanced cognitive abilities, emotional sensitivity, social understanding, moral awareness, and personality development (Turnbull et al., 2022; Yao et al., 2021). Adolescents require educational services focusing on communication, problem-solving, emotional management, and the establishment of trusting relationships (Afshar et al., 2020; Hofmans & van den Bos, 2022; Master et al., 2020).

Observations and needs analysis reveal gaps in current physical education learning, with a primary focus on the psychomotor domain. Recognizing the need to explore affective and cognitive domains, the proposed solution involves developing a learning management system specifically tailored for physical education instruction in senior high schools. This web-based system aims to provide accessible, anytime, anywhere learning, catering to different learning styles. Initial results and observations from regions in East Java underscore the suboptimal nature of current physical education learning, emphasizing the demand for accessible learning media. The development of a specialized learning management system for physical education holds the promise of not only enhancing instruction but also contributing to the broader goals of improving health and fitness levels among students, ultimately cultivating a well-rounded generation for Indonesia's future (Phan et al., 2022).

MATERIALS AND METHODS

The study was carried out in four distinct phases. The initial phase of conducting a needs analysis for the Physical Education Learning Management System (PELMS) involves a comprehensive exploration of various aspects and domains to identify specific requirements and gaps within the realm of senior high school physical education. Researchers scrutinize several key areas to gain insights into the unique needs of the educational context. These aspects may include:

Curricular Requirements: Examining the existing curriculum for physical education to identify any gaps or areas that could benefit from technological support. This involves assessing the

alignment between the curriculum and the current state of technology integration.

Student Engagement: Analyzing the level of engagement among students in physical education classes. This includes understanding how technology could enhance student participation and interest in physical activities.

Educator Needs: Investigating the requirements and challenges faced by physical education educators. This encompasses understanding the tools and resources that would support educators in delivering effective lessons and managing student progress.

Technological Infrastructure: Assessing the available technological infrastructure within the educational institution. This involves examining the current capabilities and limitations of the technology infrastructure that will host the PELMS.

Accessibility and Inclusivity: Considering the accessibility of physical education for all students, including those with diverse learning needs. Identifying gaps in inclusivity and exploring how the PELMS can address these gaps is crucial.

Administrative Requirements: Understanding the administrative and management needs associated with implementing a learning management system. This includes considerations such as data management, reporting, and system administration.

By thoroughly analyzing these aspects, researchers can pinpoint specific gaps and requirements within the current physical education landscape. This information serves as a foundation for designing and developing the PELMS to effectively address these identified needs, ensuring a tailored and impactful learning management system for senior high school physical education.

Subsequently, the development of the Physical Education Learning Management System (PELMS) takes place in the second stage. During this phase, researchers carefully consider the results of the needs analysis to inform the development process of the PELMS. The needs analysis provides crucial insights into the specific requirements and challenges within the realm of senior high school physical education. By identifying and understanding these unique needs, researchers can tailor the features and functionalities of the PELMS to effectively address the identified educational gaps.

The verification of the results of LMS development typically involves collaboration among various stakeholders, including researchers, educational experts, and potential end-users such as students and educators. Through expert assessments and group evaluations, the validity and appropriateness of the developed PELMS are thoroughly examined. This collaborative verification process ensures that the PELMS aligns with the intended educational objectives and adequately meets the identified needs, contributing to its overall effectiveness.

Calculating and deciding when the PELMS development stage is worthy of entering testing involves a meticulous evaluation of several factors. Researchers often utilize criteria such as the completion of essential features, alignment with educational goals, and the overall readiness of the system for practical implementation. The decision to progress to the testing phase is based on a comprehensive assessment of the PELMS's functionality, usability, and its potential to effectively fulfill the identified needs, ensuring a robust and reliable learning management system for senior high school physical education. Following this, a trial run is conducted to assess the effectiveness and functionality of the PELMS in the third stage. Finally, the fourth stage entails disseminating and implementing the PELMS in educational institutions. The forthcoming research will encompass the subsequent steps.

Following the Roadmap above, a needs analysis has been carried out in the previous stage. Then, the Learning Management System Application for Physical Education Learning for High Schools in East Java is developed for the next stage. The flow of the research series at this stage is as follows.

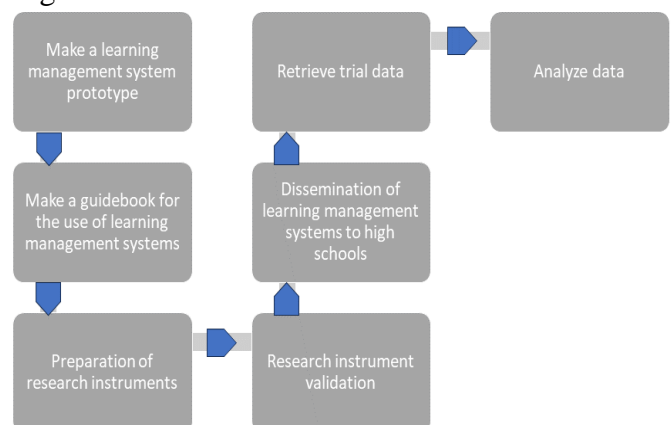


Figure 1. Flow of research stages

At this stage of the research, Research and Development were developed to develop a Physical Education Learning Management System Application for High Schools in East Java, and survey research was used to retrieve trial data for the Physical Education Learning Management System Application for High Schools.

Participant

The study participants comprised high schools located in five regions of East Java Province, specifically: (1) the northern region (Surabaya), (2) the central region (Malang), (3) the southern region (Blitar), (4) the eastern region (Banyuwangi), and (5) the western region (Madiun). The total number of students involved in the research included 96 males and 34 females.

Table 1. Age of participants

Age	Amount
15 years old	12
16 years old	45
17 years old	34
18 years old	39

Based on the data to be disclosed, which consists of identifying the problems encountered, identifying the facilities owned, identifying supporters, and identifying the goals to be achieved. So that two variables can be determined in this study. The independent variable is using the learning management system application, and the dependent variable is learning physical education in senior high schools in East Java.

Conducted in strict adherence to robust ethical guidelines, the current study received official approval from the Ethics Commission of the Faculty of Medicine at Brawijaya University in Indonesia, designated by reference number 269/EC/KEPK - UM/08/2022. All participants provided informed consent willingly, having been presented with a comprehensive volunteer form that elucidated the intricacies of the research, potential risks, anticipated benefits, confidentiality protocols, and the inherent rights granted to participants. The research meticulously followed the ethical principles outlined in the Declaration of Helsinki, prioritizing the rights and well-being of participants throughout the entire research process, including design, procedures, and confidentiality measures. Specifically, rigorous precautions were taken to safeguard the identities of vulnerable

research participants, thereby upholding a steadfast commitment to confidentiality and participant welfare.

The product also has a manual for the Learning Management System for Physical Education Learning for High Schools. The product has been validated by 3 validators consisting of (1) learning experts, (2) physical education experts, and (3) media experts to provide input on product improvements that have been prepared and produced for further trials of 130 respondents in the following areas: (1) East Java in the northern region (Surabaya), (2) East Java in the central region (Malang), (3) East Java in the southern region (Blitar), (4) East Java in the eastern region (Banyuwangi), (5) East Java, western region (Madiun).

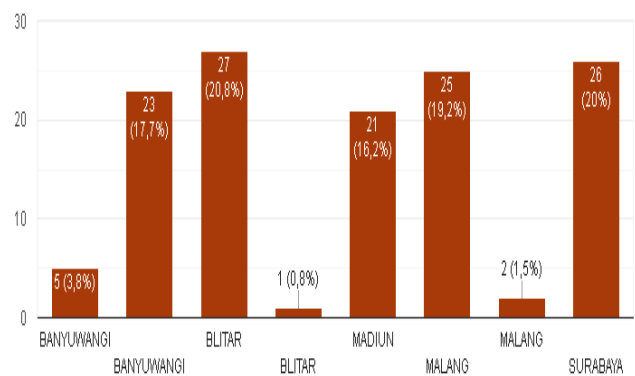


Figure 2. Respondent's district/city of origin

Data Collection Instrument

The researchers modified and created the instruments utilized for measuring research variables, considering the translation of the variables into research indicators. The research employed a product trial instrument in the form of a questionnaire that underwent validation by specialists in learning, physical education, and learning media technology. The validation component encompasses various elements, such as the clarity of the questionnaire title, the clarity of the question items, the clarity of instructions provided for completing the questionnaire, the accuracy of statements aligning with the expected answers, statements that are relevant to the research objectives, statements that outline the intended aspects to be achieved, statements that convey accurate information, statements that contain complete ideas, the use of language that is easily comprehensible, the use of compelling

language, and adherence to the rules of the Indonesian Language Spelling Standardisation. Subsequently, the validators assessed each aspect and assigned scores using a Likert scale, **Table 1. Instrument Grid**

encompassing a numerical range from 1 to 4. Subsequently, presented below is the grid, including the questionnaire instrument.

Number	Indicator	Item number	Number of questions
1.	The features of learning management systems in the context of physical education learning	1,2	2
2.	The learning management system (LMS) in physical education learning possesses several supporting aspects	3,4,5,6	4
3.	Assist in facilitating the process of acquiring knowledge and skills	7	1
4.	The advantages of utilizing a learning management system in physical education instruction	8	1
5.	The advantages of utilizing a learning management system in physical education instruction	9	1
6.	The learning management system (LMS) offers several benefits in the context of physical education instruction	10	1
7.	The Learning Management System (LMS) utilized in physical education learning has limitations and shortcomings	11	1
8.	Further development steps	12	1

Data Analysis

The acquired data underwent thorough qualitative descriptive analysis to elucidate its intrinsic features and present a condensed overview of the information. This methodology entails scrutinizing numerical data to depict and comprehend different facets of the dataset without extrapolating conclusions beyond the studied sample. The process of qualitative descriptive analysis commences with the utilization of descriptive statistics to succinctly summarize the dataset. Visual aids, such as tables, may be employed to visually represent the data, offering a lucid depiction of its distribution and patterns.

RESULTS

The research outcomes are reflected in the development of the Physical Education Learning Management System (PELMS) for high schools. This system is designed as a comprehensive application for managing and facilitating learning activities in physical education. It is accessible through smartphones and personal computers by entering the keyword "http://192.168.108.123/" into the Google search engine. Users can log in to the system using their designated. The product that has been developed contains menus: (1) account dashboard, (2) site administration, (3) users, (4) courses, (5) grades, (6) plug-in, (7) appearance, (8) servers, (9) reports, (10) development. The product

is also equipped with a manual to make operating easier.

The data obtained from the results of trials on experts and respondents consisted of 2 types of data: qualitative and quantitative. Qualitative data was collected and then reduced into several descriptions in the form of sentences. The quantitative data underwent inferential descriptive statistics analysis and were afterward presented as percentage figures. The following is a summary of the qualitative data obtained from several validators and respondents to the products that have been compiled, which are described as follows: (1) some files cannot be opened after being uploaded, (2) Have not added a forgotten password to the login menu, (3) On the menu for import add user only supports CSV format, (4) Applications sometimes experience bugs and frames due to hosting problems, (5) The specifications of the menus contained in the learning management system are so complex that sometimes they forget menus.

Furthermore, quantitative data will be presented as percentage figures grouped into (1) expert validation data analysis and (2) trial data analysis. Data from the expert analysis was collected using a non-questionnaire questionnaire instrument with trial subjects using physical education experts, learning experts, and learning technology experts. The findings of the expert analysis are displayed in the expert analysis table.

Table 2. Data from the analysis of physical education experts

Number	Component	Minimum Score	Max Score	Score Result	Percentage (%)
1	Constructing a learning management system within the context of physical education instruction	3	12	12	100%
2	The advantages associated with developing a learning management system in physical education instruction	3	12	10	83,33%
3	The prospective development of a learning management system in physical education instruction.	3	12	10	83,33%
Overall average		9	36	32	88,86%

Table 3. Data from the analysis of learning experts

Number	Component	Minimum Score	Max Score	Score Result	Percentage (%)
1	The concept of developing a learning management system in physical education learning	3	12	10	83,33%
2	The advantages associated with developing a learning management system in physical education instruction	3	12	11	91,66%
3	The prospective development of a learning management system in physical education instruction	3	12	11	91,66%
Overall average		9	36	32	88,86%

Table 4. Data on learning technology analysis results

Number	Component	Minimum Score	Max Score	Score Result	Percentage (%)
1	Features of the learning management system	3	12	10	83,33%
2	Supporting features in the learning management system.	3	12	9	75%
3	The overall appearance and content of the learning management system	3	12	11	91,66%
Overall average		9	36	30	83,33%

Based on Table 2, the validation results of physical education experts consisting of 3 components obtained a score (F) of 32 out of a maximum total score (N) of 36 with a percentage result of 88.86%. The product has received validation from experts in the field of physical education, indicating that it is ready to forward to the trial stage. According to the data presented in Table 3, the learning validation process yielded a score (F) of 32 out of a possible total score (N) of 36, resulting in a percentage of 88.86%. The validation of learning experts has yielded results that support the progression of the product to the trial stage.

According to the findings presented in Table 4, the validation outcomes of a group of learning technology specialists were assessed using three distinct components. This assessment's acquired score (F) was 30 out of a maximum total (N) of 36, resulting in a percentage score of 83.33%. The validation of learning technology specialists has

yielded results that indicate the product is suitable for progression to the trial stage. Data from the group trial results were obtained using a non-questionnaire questionnaire instrument with the help of Google Forms. The test subjects used 130 respondents who were in the regions: (1) East Java in the northern region (Surabaya), (2) East Java in the central region (Malang), (3) East Java in the southern region (Blitar), (4) East Java in the east (Banyuwangi), (5) East Java west region (Madiun).

The following is an analysis of each item filled in by each respondent: (1) East Java (26 respondents in the northern region of Surabaya), (2) East Java in the central region (Malang) with 27 respondents, (3) East Java for the southern region (Blitar) with 28 respondents, (4) East Java for the eastern region (Banyuwangi) with 28 respondents, (5) East Java for the western region (Madiun) with 21 respondents.

Table 5. Respondents' responses

No	Item	Respond	Description	
			%	f
1	Respondents' responses to the ease of features in the learning management system	Very easily	87.7	114
		Easily	12.3	16
2	Respondents' responses to the clarity of features in the learning management system	Very clearly	76.2	99
		Clearly	23.8	31
3	Respondents' responses to the ease of supporting features in the learning management system	Very easily	82.3	107
		Easily	17.7	23
4	Respondents' responses to the attractiveness of supporting features in the learning management system	Very interesting	85.4	111
		interesting	14.6	19
5	Respondents' responses to the clarity of supporting features in the learning management system	Very clearly	84.6	110
		Clearly	15.4	20
6	Respondents' responses to the complex level of supporting features in the learning management system	Very complex	86.9	113
		complex	13.1	17
7	Respondents' responses to the existence of a learning management system in Physical Education	Very helpful	85.4	111
		Helpful	14.6	19
8	Respondents' responses about the benefits of the learning management system	Very useful	88.5	115
		useful	11.5	15
9	Respondents' responses to the potential of the learning management system	Very potential	88.5	115
		potentially	11.5	15
10	Respondents' responses to the advantages of the learning management system	Very many advantages	93.1	121
		Advantages	6.9	9
11	Respondents' responses to the deficiencies and weaknesses of the learning management system	Few deficiencies	97.7	127
		Very few deficiencies	2.3	3
12	Respondents' responses to the further development of the learning management system	Highly recommended	72.3	94
		recommended	27.7	36

According to the data presented in Table 5, the findings indicate that most respondents (87.7%) perceived the characteristics of the learning management system application in high school physical education to be very easy. In comparison, a minority (12.3%) found them easy. According to the data presented in Table 5, the replies about the clarity of features in the learning management system application in high school physical education learning indicate that 76.2% of participants found the features very clear. In comparison, 23.8% found them to be precise. According to the data presented in Table 5, it can be observed that the replies on the ease of utilizing features in the learning management system application for high school physical education learning indicate that 82.3% of participants found it to be straightforward. In comparison, 17.7% found it to be easy.

According to the data presented in Table 5, it can be observed that the responses on the appeal of features in the learning management system application utilized in high school physical education instruction yielded a percentage distribution of 85.4% for the category "very interesting" and 14.6% for the category "interesting." Based on the data presented in Table

5, the participant's perceptions of the clarity of supporting features in the learning management system application used in high school physical education learning were predominantly positive. Specifically, 84.6% of respondents reported that the supporting features were perceived as "very clear," while 15.4% indicated they were perceived as "clear." Based on the data shown in Table 5, it can be observed that the responses of the degree of complexity associated with the supporting features in the learning management system application utilized in high school physical education learning yielded a percentage distribution of 86.9% for the category "very complex" and 13.1% for the category "complex."

According to the data presented in Table 5, the findings indicate that a significant majority of respondents, about 85.4%, perceived the learning management system application to be highly beneficial in facilitating the learning process in high school physical education. Conversely, a smaller proportion of respondents, around 14.6%, reported that the program provided some assistance. According to the data presented in Table 5, the outcomes of the survey responses about the advantages of utilizing the learning management system application in high school

physical education instruction indicate that 88.5% of participants deemed it highly beneficial. In comparison, 11.5% considered it to be helpful.

According to the data presented in Table 5, the advantages of utilizing the learning management system application in high school physical education instruction indicate a high level of potential. Specifically, 88.5% of the participants responded that the application is exceptionally prospective, while 11.5% considered it potentially beneficial. According to the data presented in Table 5, it can be observed that the replies on the benefits of utilizing the learning management system application in the context of high school physical education learning indicate that a majority of 93.1% of participants expressed a high degree of agreement with the presence of numerous advantages. Conversely, a smaller proportion of 6.9% of respondents acknowledged the existence of advantages, albeit to a lesser extent.

According to the findings presented in Table 5, it can be observed that the replies of the advantages of the learning management system in the context of high school physical education learning indicate that 97.7% of participants reported few defects. In comparison, 2.3% reported a small number of deficiencies. According to the data presented in Table 5, the replies on the advantages of utilizing the learning management system application in high school physical education instruction were predominantly positive. Specifically, 72.3% of the participants expressed a high level of recommendation, while 27.7% indicated a moderate recommendation.

DISCUSSION

Based on the 12 questions posed to the respondents, an overall percentage of 85.72% is obtained with the category of proper use. So it can be concluded that from the results of product trials on respondents, the product developed as a learning management system for physical education learning can be used in high school physical education learning.

Following a comprehensive examination of the various stages involved in the research and development of a learning management system for physical education in senior high schools, the objective of which is to facilitate a flexible and accessible learning environment for physical education, the outcomes of this study encompass

two main products. Firstly, a learning management system application has been created to support physical education learning on both smartphones and PCs/Laptops. This application can be accessed by entering the URL <http://192.168.108.123/> on Google and logging in using the designated username and password. Secondly, a guidebook has been produced to provide instructions on effectively utilizing the learning management system for physical education learning.

Various advantages can be identified based on the outcomes derived from the research process. Firstly, it is observed that implementing a learning management system for physical education learning is only prevalent in some high schools in East Java. Secondly, the utilization of a learning management system in physical education learning can introduce novel and visually engaging learning media.

The present study is based on the findings of a research project that involved conducting group trials on a total of 130 participants from various regions in East Java, namely: (1) the northern region (Surabaya), (2) the central region (Malang), (3) the southern region (Blitar), (4) the eastern region (Banyuwangi), and (5) the western region (Madiun). The overall yield of the trials was determined to be 85.72%. Based on the study's findings, the proposed learning management system for physical education can potentially enhance learning. The present study investigates web-based learning management systems for assessing students' comprehension of concepts and characters. Specifically, the research examines the relationship between student replies and their corresponding outcomes, focusing on achieving a percentage score exceeding 82.5% in the category denoting high proficiency. Gain test results for understanding the concept of 0.56 in the medium category, meaning that the learning management system effectively increases students' understanding of concepts (Muhardi et al., 2020; Yamani et al., 2022). Additional studies that align with this research involve utilizing a learning management system to manage online learning in educational settings. The findings of these studies are based on the literature review conducted. The learning management system (LMS) is a widely sought-after platform in online education, known for its significant level of trust, as indicated by its 82.2% rating. According to the findings of this study, the learning management system stands out

among various online platforms due to its extensive features, leading to a more varied learning encounter. The research indicates that employing a learning management system (LMS) or a blend of LMS-centered learning approaches proves successful in enhancing participation, elevating learning achievements, and fostering student enthusiasm, earning it a positive evaluation. Utilizing learning management systems can foster a high level of autonomy in the learning process, falling within the range of 78.8 to 81.5, reaching the very high category (Mehroliya et al., 2021).

Learning using a learning management system requires special attention because it will be different from learning using a learning management system or without it. Included in choosing learning methods. The learning method describes the methods used by the teacher in establishing relationships with students during teaching (Roy & Brown, 2022; Turnbull et al., 2021). Several methods are commonly used when learning management systems are included in a lesson, such as full electronic, distance, and blended learning. The subject of discussion pertains to electronic learning that exclusively relies on distance education. This is achieved by utilizing a learning management system as a facilitator of learning without any involvement or interference from external parties during the process (Vinci et al., 2021). Based on the studies above and perspectives, it can be inferred that a physical education learning management system can enhance the physical education learning experience by facilitating a flexible learning environment accessible at any time and location. This, in turn, can enhance the overall quality of physical education learning and foster more significant control over learning management.

Conclusion

The research on the use of a learning management system (LMS) in senior high school physical education effectively addresses its objectives. The study highlights the acceptance of the LMS by students and educators, emphasizing its potential benefits for tailored physical education. The most significant results for the development of science and technology include the recognition of the LMS as a facilitator of online learning, transcending traditional boundaries and offering advantages in uninterrupted access. Recommendations for further research include

implementing LMS products in physical education, utilizing expert and group assessments, and disseminating findings for broader use. Additionally, the researcher suggests conducting a wider evaluation of the developed products to ensure conformity with environmental conditions and institutional needs. Further research should also consider contextual factors, material relevance, and the inclusion of comparison groups for more meaningful results.

Conflict of interest

The authors state that they have no conflicts of interest. They express gratitude to Universitas Negeri Malang for providing financial support that has enabled the successful completion of this research.

Ethics Statement

Conducted in strict adherence to robust ethical guidelines, the current study received official approval from the Ethics Commission of the Faculty of Medicine at Brawijaya University in Indonesia, designated by reference number 269/EC/KEPK - UM/08/2022.

Author Contributions

Study Design, SA, AFF and NKM; Data Collection, AFF and NKM; Statistical Analysis, AFF and NAMM; Data Interpretation, SA, AFF and NAMM; Manuscript Preparation, SA, AFF, NKM and NAMM; Literature Search, AFF and NKM. Each of the authors has thoroughly reviewed and granted approval for the final published version of the manuscript.

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