# Developing the Physics Learning Management System (PLMS) to Support Blended Learning Models

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***Abstract*—The learning process has undergone significant transformations through the adoption of online approach, such as fully online models and blended learning. The blended learning system is becoming increasingly popular due to its effectiveness in catering to a diverse student population while enriching the learning environment through the integration of online teaching resources. This research aims to develop a Physics Learning Management System (PLMS) tailored to support blended learning practices within the field of physics education and to assess its viability. This research follows a Research and Development (R and D) framework, employing the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) design. The feasibility and usability test are carried out on PLMS. The feasibility included functionality, probability, media and material feasibility. The developed PLMS has aligned with the ISO-9126 standard for system feasibility testing. Notably, feedback from administrators, teachers, and students indicates a high level of satisfaction with the system's functionality, ensuring smooth operation across various user roles. Moreover, the PLMS demonstrates cross-browser compatibility, accommodating both mobile and desktop environments, thus meeting stringent standards for system reliability. Evaluation of media and material quality yields commendable results, positioning the PLMS as a valuable instructional tool for supporting blended learning methodologies in senior high school physics education. Usability testing further confirms the PLMS's efficacy, with users finding the system intuitive, user-friendly, and engaging. This platform effectively facilitates blended learning practices in high school physics education, thereby contributing to the ongoing discourse on technology integration in educational settings.**

***Keywords*—blended learning, learning management system, physics learning, e-learning**

## I. Introduction

Given recent educational policy changes, the landscape of learning has indeed evolved, marked notably by the emergence of online learning in both fully digital and blended formats. Blended learning, a hybrid approach combining traditional face-to-face instruction with online components, has gained prominence [1−3]. This methodology offers a flexible and effective means of delivering educational content [4−6], accommodating diverse learning contexts [7, 8]. Students, equipped with a variety of learning tools, find blended learning environments conducive to their needs and preferences [9, 10]. Blended learning integrates a range of resources, including web-based platforms, video streaming, synchronous and asynchronous audio communication, alongside traditional classroom interactions [11, 12].

The current shift in learning methodologies reflects the growing necessity for rapid advancements in educational technology. Across nations, there is a notable emphasis on integrating Information and Communication Technology (ICT) as the cornerstone of educational systems [13−17]. This trend is particularly evident in the adoption of the Independent Learning Curriculum, which promotes autonomous learning. Through this curriculum, students are empowered to cultivate self-regulation and independence, crucial skills in today's dynamic learning environments [18, 19]. Consequently, educators are demanded with continually enhancing the quality of ICT-based instruction, ensuring both effectiveness and efficiency in learning outcomes [20]. Educational institutions that embrace blended learning stand to benefit from the advancements in learning technology with high-quality outputs that align with contemporary demands and challenges [21, 22].

Despite the easing of pandemic restrictions, many high schools in North Sumatra have chosen to continue online learning practices. Insights gathered from online interviews with Physics teachers reveal ongoing efforts to align curricula with advances in science and technology, primarily through the utilization of ICT for fully online learning modalities. However, assessments by educators and parents indicate that online learning has not consistently met desired learning objectives and student outcomes [23, 24]. Parents generally have negative beliefs about the value and benefits of online learning and prefer traditional learning for their children [25]. The lack of social interaction and perceived limitations in facilitating activities, practice sessions, and skill development further compound these concerns [26, 27]. In response to these challenges, high schools are transitioning towards a blended learning approach, blending online and face-to-face instruction in varying proportions. This shift, typically with a composition of 30% online learning and 70% face-to-face instruction, is tailored to the specific needs of each school [28]. In fact, there is no standardized approach to blending autonomous online learning, synchronous or asynchronous online learning, and traditional classroom-based instruction, with each institution adopting a unique strategy.

Most institutions implement blended learning through the use of a Learning Management System (LMS), tailored to the specific characteristics of Physics materials and the

individual needs of students. Currently, available LMS applications, such as Schoology, Edmodo, and Google Classroom, lack dedicated features for Physics instruction and are accessible to all users, thus compromising privacy and personalization for teachers. Common drawbacks of existing LMS platforms include unattractive interfaces, limitations in file sharing capacity, potential for assignment submission delays, and restricted autonomy for teachers in content customization and instructional design. Moreover, certain platforms like Schoology have been found to be susceptible to issues such as plagiarism and assignment submission manipulations [29]. To address these limitations, there is a urgent need for the development of an innovative LMS application, especially for Physics instruction. Such an application should offer personalized learning and assessment features while safeguarding privacy and promoting academic integrity [30−33].

Several studies have consistently demonstrated the positive impact of blended learning across various aspects of the educational process, from learning activities [34, 35] to student motivation and academic performance [36, 37]. Blended learning environments foster enhanced communication among students compared to purely face-to-face or fully online settings [4]. The structured combination of in-person and online interactions creates a sense of urgency and mutual dependency between teachers and students, driving engagement and curiosity. From a technical standpoint, blended learning affords students the flexibility to engage with course materials remotely through online platforms while providing opportunities for face-to-face interactions to seek clarification on complex concepts. Challenges inherent in traditional face-to-face instruction can be mitigated through the integration of online components, while students' difficulties in navigating online learning tools can be addressed through personalized support and guidance during face-to-face sessions [38].

An understanding of Learning Management Systems (LMS) is essential, as it serves as software designed for administrative purposes, documentation, resource discovery, activity tracking, and the provision of training materials for online learning activities conducted over the internet. LMS, also known as Course Management Systems (CMS) or Virtual Learning Environments (VLE), functions as internet-based software applications facilitating various aspects of online learning, including content delivery, organization, administration, and assessment [39, 40]. In the context of this research design, Moodle-based LMS is employed, leveraging a PHP development platform alongside a MySQL database. Moodle, a well-established LMS, has been effectively utilized in educational settings for over a decade [41].

The design of the Physics Learning Management System (PLMS) commences with the development of a comprehensive Learning Implementation Plan centered on Blended Learning principles. This plan encompasses the identification of learning sources, materials, assessment tools, and the creation of multimedia presentations. Subsequently, the PLMS application is designed, with teaching materials uploaded and the application rigorously tested for functionality and usability. Within the PLMS, lesson plans outline learning activities, specifying the mode of delivery—whether online or face-to-face—and providing clarity on the timing and sequence of each. During online learning sessions, students engage in discussions, share findings, and delve deeper into course materials. Face-to-face interactions complement online learning by offering opportunities for clarification, reinforcement, and enrichment of concepts [38]. This dynamic interplay between online and face-to-face modalities enhances the learning experience, fostering deeper comprehension and retention of subject matter.

This research tries to develop an innovative Physics Learning Management System (PLMS) application and assess its feasibility. A primary objective is to enhance student-teacher interaction, recognizing its pivotal role in fostering effective learning experiences. Furthermore, the research team anticipates that the outcomes of this study will yield significant benefits for the broader community by enhancing the quality of online learning. By aligning with ongoing advancements in science and technology, the PLMS application is poised to address contemporary educational challenges, ultimately contributing to the continual improvement of educational practices.

## II. Methods

### A. Participants

The research focuses on students and physics teachers as respondents from two senior high schools in Medan city, North Sumatera. These respondents provided opinions and evaluations to assess the readability of the test product. The methodology involved teachers and students engaging in learning activities utilizing the PLMS application. Subsequently, they were requested to complete the users' readability to gather comprehensive feedback from both user groups.

In this study, there are 78 students and 10 teachers as respondents came from two senior high schools in North Sumatera Indonesia. All students and teachers willingly participated in the data collection process, demonstrating voluntary engagement without any coercion. This commitment to voluntary participation underscores the integrity of the research methodology and ensures that responses are provided freely and without external influence. The demographic data of respondents has been summarized in Table 1.

Table 1. Respondents demographic information

| Respondents | Item | Frequency |
|---|---|---|
| Teachers | Male | 4 |
| | Female | 6 |
| | Total | 10 |
| Students | Male | 31 |
| | Female | 47 |
| | Total | 78 |

### B. Research Methodology

This study employed Research and Development/R and D with the ADDIE design—Analysis, Design, Development, Implementation, and Evaluation (Fig. 1). The following is a description of each step of the research.

#### 1) Analysis

Three analyses were performed: needs analysis, curriculum analysis, and material analysis, which included a

review and analysis of the curriculum, lesson plans, and learning documents of senior high schools. Curriculum analysis, problem analysis, and learning document analysis are commonly conducted within schools using internet-based resources.

*2) Planning design*

- Designing lesson plans, teaching materials and assessment instruments. The initial design for learning documents was Blended Learning-based lesson plans, teaching materials, and assessment instruments that were adapted to the school's curriculum.
- Designing PLMS applications of the learning management based on Moodle application for the Physics material.
- Designing the feasibility instruments for evaluating the PLMS application that involves assessment criteria and instruments to gauge its suitability and effectiveness. These instruments were administered to media expert validators who assess various aspects of the PLMS application.
- Designing User Response Questionnaire to know users' respond to the developed product. The indicators included the clarity of the learning content, students' motivation, content mastery, exercises/assignments, attractiveness, navigation and readability.

*3) Development*

At this stage, the development process for the Physics Learning Management System (PLMS) proceeds as follows:

- Moodle Configuration: the PLMS is created within the Moodle platform according to the system development design. This involves configuring Moodle and incorporating necessary modules such as virtual classes, assignments, real-time quizzes, and discussion forums. Additionally, learning materials and assessment instruments are compiled and integrated into the platform.
- Software Development: the PLMS software is developed using HTML, PHP, and MYSQL programming languages. The development process entails several steps, including system design, coding, and installation on a hosting server.
- System Design: The initial step involves designing the system layout, including templates, databases, and algorithms.
- Coding: the PLMS program is coded using PHP programming language, ensuring functionality and compatibility with the Moodle platform.
- Installation: the developed software is installed on a hosting server selected for its unlimited bandwidth, ensuring smooth access even with high visitor traffic. Additionally, a domain is acquired to facilitate user access to the PLMS.
- Content Integration: following software development and installation, teaching materials are uploaded and organized within the PLMS. This includes curriculum materials, lecture notes, multimedia resources, and assessment tools, ensuring comprehensive support for teaching and learning activities.
- Learning Documents: making a material syllabus and material in PPT format, video as well as assignments and exam for final assessment. Learning documents such as material syllabus, teaching materials and test instruments are included into the LMS according to the features in the application.
- Feasibility Test: the developed PLMS applications is tested for feasibility through the ISO-9126 standard on aspects of functionality and probability. It is to ensure all the features in the PLMS can run based on the functions before the implementation stage.
- Media and Material Feasibility Test: it is to review and obtain assessment from media and material experts. This stage employed questionnaire with specific indicators of media and physics material.

*4) Implementation*

- User Testing: This phase involves testing the PLMS application based on feedback from users, namely teachers and students. The implementation technique entails teachers and students actively engaging with the PLMS application for learning purposes. Subsequently, both teachers and students are asked to complete a readability questionnaire designed to assess their experience and satisfaction with the PLMS application.
- Data Interpretation and Analysis: During the interpretation phase, the overall data collected from the application feasibility test and user response tests is examined. This involves analyzing responses from both teachers and students regarding the usability, effectiveness, and satisfaction with the PLMS application. This process involves synthesizing and interpreting the data to draw meaningful conclusions about the PLMS application's suitability for supporting physics education in a senior high school context.

*5) Evaluation*

At this stage, a comprehensive evaluation of all research steps, reflections, and documentation is conducted to ensure that the final product, the PLMS application. It is found that the developed product has been well-suited for supporting the learning process within blended learning system at the senior high school level.

### *C. Design of PLMS Development*

Based on the results of the analysis of learning needs at senior high schools, it has been determined that there is currently a lack of a dedicated learning management system application facility to support online learning. Therefore, based on the needs analysis, the design for the system can be outlined in Fig. 1. Besides that, Fig. 2 is using case diagram to show users can work around the system.

### *D. Data Analysis Technique*

This research employs quantitative analysis techniques to evaluate software quality based on ISO-9126 standards. The analysis covers four main aspects: Functionality, Probability, Feasibility, and Usability. Quantitative data analysis is conducted using the results from the system's feasibility tests, which adhere to the ISO-9126 standard. These results are aggregated into an overall score, comprehensively evaluating the PLMS application's performance. The numerical classification is derived from the scoring system and is then interpreted using qualitative sentences [42].

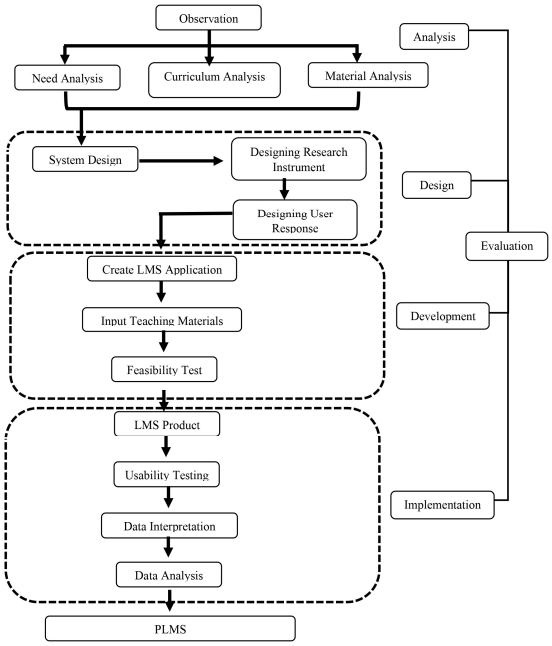



Fig. 1. System development design.

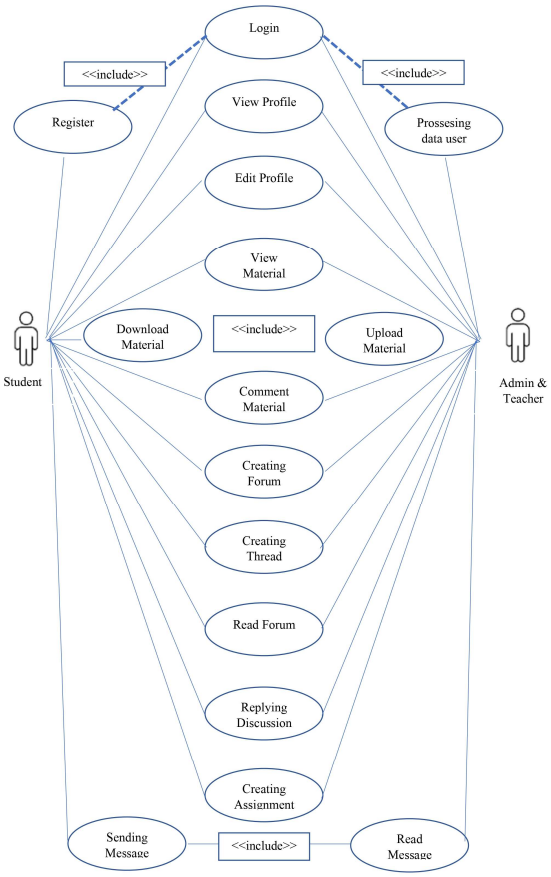



Fig. 2. Use case design.

Data of Functionality, Media/Material Feasibility, and Usability Aspects are calculated using the formula:

$$P = \frac{the\ obtained\ score}{the\ maximum\ score} \times 100\%$$

This percentage is then compared to the Likert scale, providing insights into the attitudes and opinions of individuals or groups regarding the occurrence [43]. The interpretation of the Likert scale is provided in Table 2. Probability Aspects are evaluated through field testing using various tools and simulations from dedicated websites. These tests aim to assess the compatibility and performance of the PLMS application across diverse environments, including evaluations through webpagetest.org and direct testing on various web browsers (desktop and mobile versions).

Table 2. Interpretation of Likert scale results

| Score Percentage | Description |
|---|---|
| 0%–20% | Very Poor |
| 20%–40% | Poor |
| 40%–60% | Moderate |
| 60%–80% | Good |
| 80%–100% | Very Good |

Additionally, the feasibility and usability of the PLMS application were analyzed using The Standardized Universal Percentile Rank Questionnaire (SUPR-Q) adapted from Jeff Sauro [44]. This approach provides a comprehensive assessment of the application's usability and feasibility, offering valuable insights into its suitability for educational purposes. Using standardized assessment techniques ensures a thorough evaluation of the PLMS application's quality across multiple dimensions, enabling informed decision-making in educational settings.

## III. Result and Discussion

The research aims to develop a learning management application system tailored for physics education in senior high schools. Employing the ADDIE development model (Analysis, Design, Development, Implementation, and Evaluation), In addition to the ADDIE model, the research incorporates system feasibility testing based on the ISO-9126 standard.

### A. PLMS Concepts

In the development step, PLMS application has been created where the display of the resulting test system can be viewed more detailed as follows.

#### 1) Administrator's page

Login: The login page is for entering the username and password, along with a "Sign In" button. The layout of the display is in the middle to facilitate and adjust the user's view. The interface of the administrator page can be seen in Fig. 3.

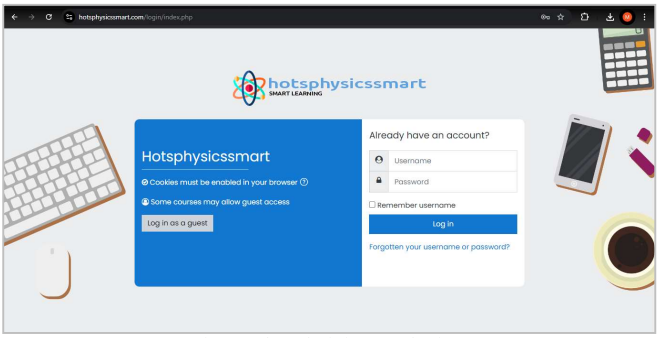



Fig. 3. The administrator login.

Home Dashboard Page. It displays home, courses, timeline and others as presented in Fig. 4.

Course Page. It presents the lesson plans, learning materials as shown in Fig. 5.

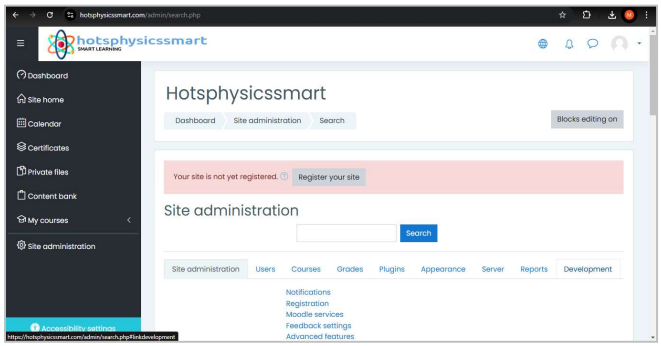



Fig. 4. The administrator dashboard.

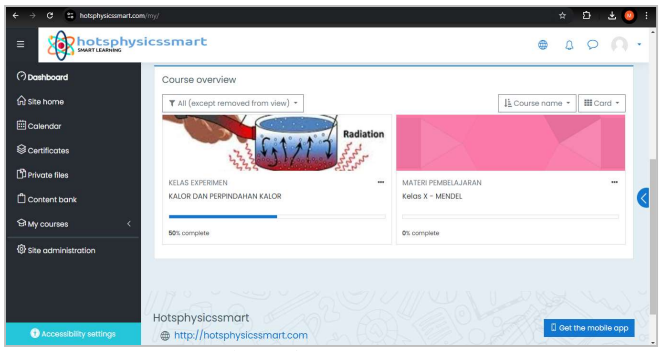



Fig. 5. The courses page.

*2) Teacher's page*

There is a text box available for entering the username, password and the sign in button. The display of the login page can be seen in Fig. 6.

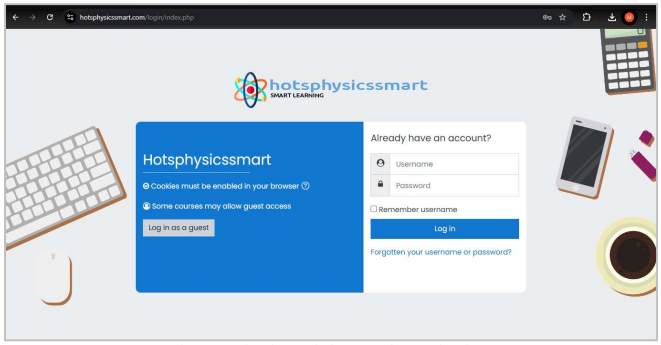



Fig. 6. Display of the teacher's login.

The Home Dashboard page displays the home view, courses, timeline and others as presented in Fig. 7.

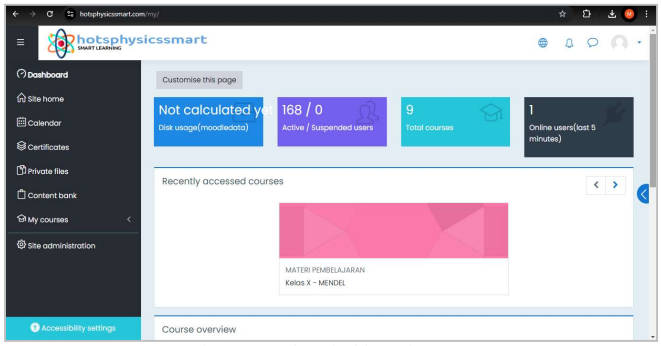



Fig. 7. Teacher dashboard page.

The Courses page displays the lesson plans, learning materials and others as shown in Fig. 8.

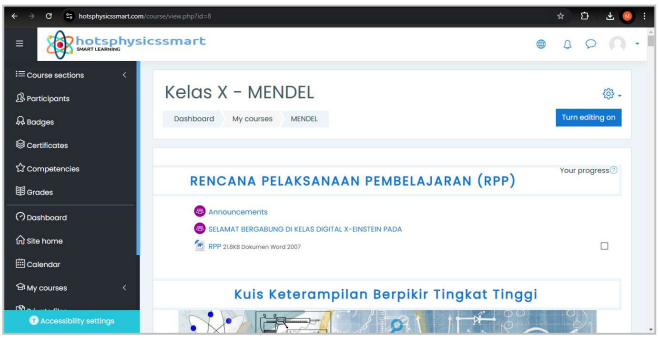



Fig. 8. Display of courses teacher's.

*3) Student's page*

Login: The login page includes fields for entering the username and password, along with a "Sign In" button (Fig. 9). The layout is centered on the screen for easy viewing and adjustment.

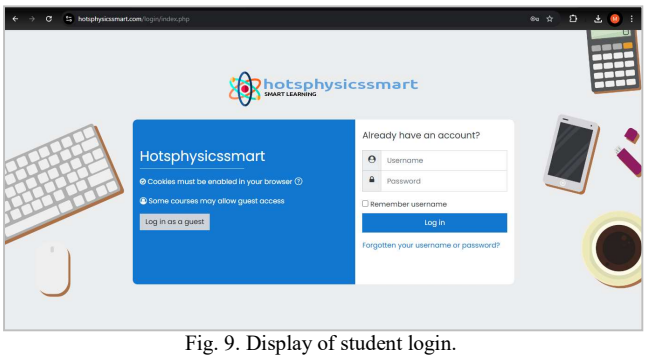



Fig. 9. Display of student login.

Home Dashboard Page: This page serves as the main dashboard, showcasing the home view, available courses, timeline, and other relevant information. Fig. 10 provides a visual representation of the dashboard home page layout.

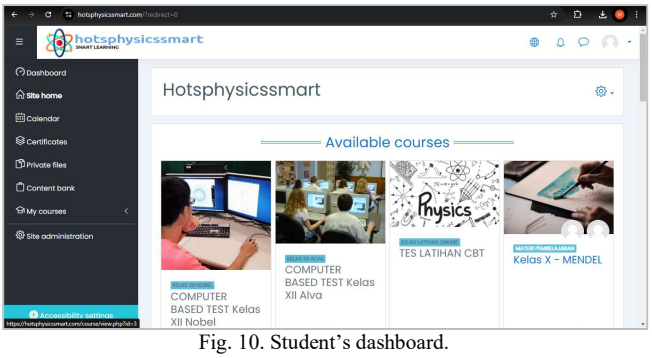



Fig. 10. Student's dashboard.

Course Page: The Courses page presents lesson plans, learning materials, and other relevant content. Fig. 11 illustrates the layout of the courses page view.

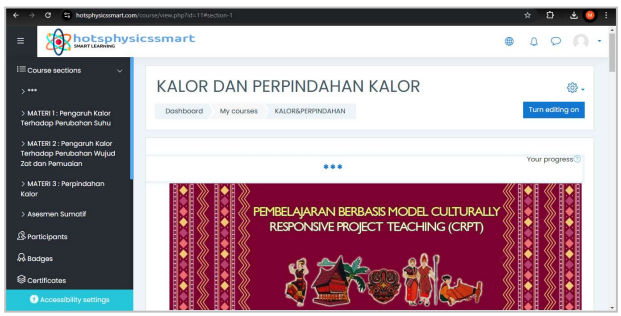



Fig. 11. Display of student courses pages.

### B. Feasibility and Usability Test of PLMS

To ensure the quality and suitability of the Physics Learning Management System (PLMS), a feasibility and usability test are conducted. This test assesses whether the Moodle system is feasible for adoption by users, including administrators, teachers, and students. The ISO/IEC 9126 standard is utilized as a benchmark standard, defining entities with capabilities to meet user needs. Instead, this evaluation is not solely based on overall characteristics. Specific aspects, such as functionality and probability, are also rigorously assessed. The validation tests involving media and material experts are conducted to further validate the system's feasibility.

#### 1) Functionality test

The functionality aspect of software pertains to its ability to fulfill stated and implied requirements, thereby meeting user needs under specific conditions. This characteristic is assessed through testing software functions by expert validators. Functional testing involves a comprehensive review of indicators from admin users, teachers, and students. This includes testing all functions such as login, menu navigation, user management, device management, and logout functionality. The functionality test results are summarized in Table 3, showing 84.70% for administrators, 81.17% for teachers, and 83.63% for students. These scores indicate effective system performance and adherence to expected requirements, all within the 'very good' category.

Table 3. Functionality test results

| No | Functionality | Percentage |
|---|---|---|
| 1. | Admin | 84.70 % |
| 2. | Teacher | 81.17 % |
| 3. | Students | 83.63 % |

#### 2) Probability test

Software's ability to be transferred from one environment to another is known as probability or portability [45]. The PLMS application underwent portability testing across various contexts, including desktop and mobile browsers. Desktop trials involved Mozilla Firefox, Microsoft Edge, Opera, and Google Chrome browsers. For the mobile environment, testing was conducted on Google Chrome for Android, Opera Mobile for Android, and the Samsung Galaxy A50 device. Both direct testing and simulation via web platforms were employed during the testing process. The results of the portability aspect test are summarized in Table 4.

#### 3) Top of form

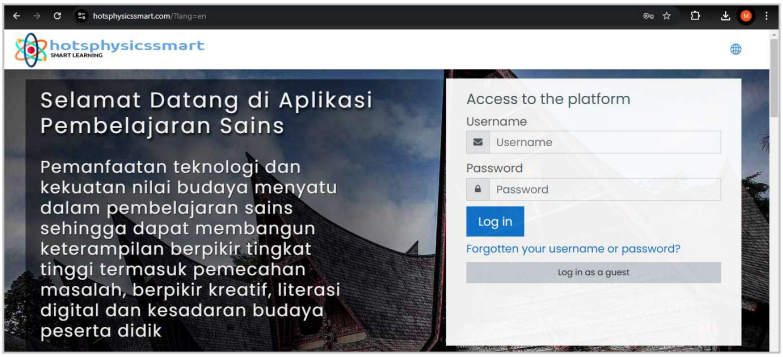
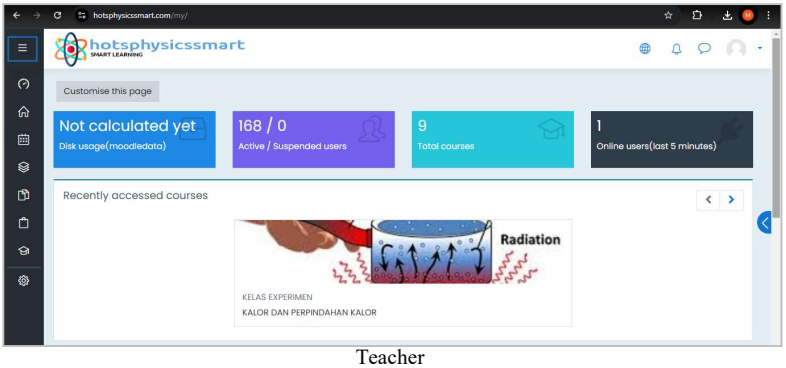
The data of the probability test results of the online test system with the complete results can be seen in the probability attachment. Based on tests in various environments, such as Google Chrome through Mobile and Desktop applications, conducted by admins, teachers, and students (Table 4), the analysis results can be seen in Table 5.

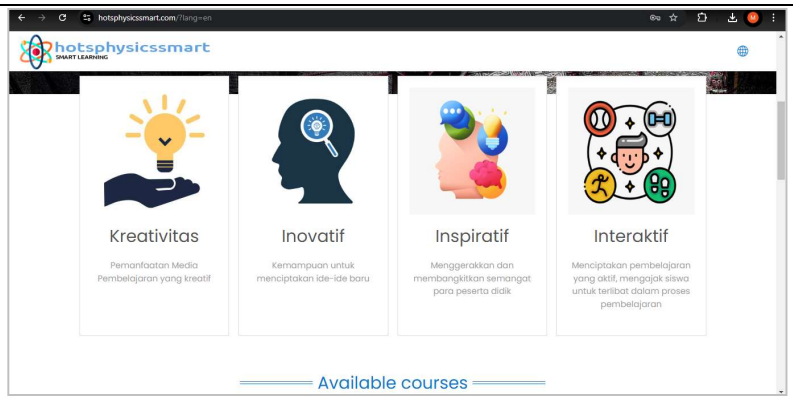
Based on the results of the probability test of the system based on the ISO-9126 standard, it can be said that the PLMS application has met the Probability aspects.

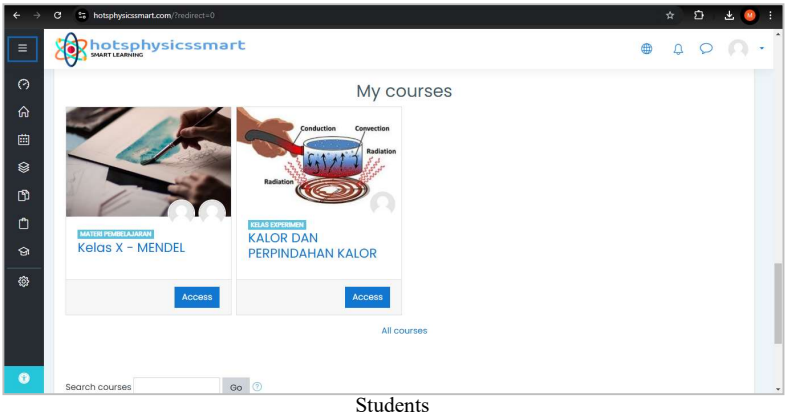
#### 4) Media feasibility test

Media feasibility testing of the PLMS application in this research was intended to obtain information from media experts regarding the quality of the developed media. Table 6 displays the media expert assessment results, with the PLMS application scoring 86 out of 100, representing an 86% presentation level, placing it in the "very good" category and affirming its suitability for research and learning purposes.

Table 4. Probability test results

| No | Browser | Display | Description |
|---|---|---|---|
| 1 | Google Chrome (Desktop) | Admin   Teacher   | Succeed |




Students

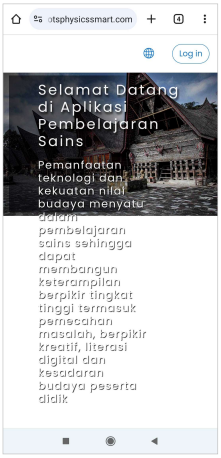
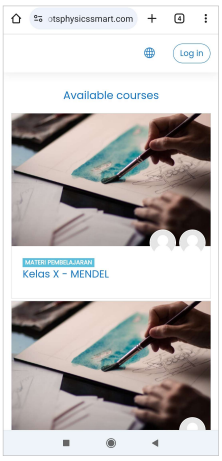
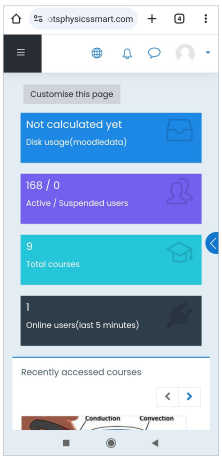
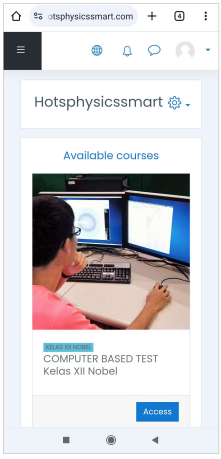
| | | | | |
|---|---|---|---|---|
| 2 | Google Chrome (Mobile) |   Teacher   Student   Teacher   Student | Succeed |

Table 5. Probability aspect test results

| Evaluated Aspects | Results |
|---|---|
| PLMS access in a desktop browser | PLMS can be accessed via Google Chrome's desktop browser |
| PLMS access in a mobile application | PLMS can be used with a mobile-based browser such as Google Chrome on Android |

Table 6. Media feasibility test results

| No | Indicator | Criteria of Assessment | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| 1 | Front Page | | | | | √ |
| 2 | images Display | | | | √ | |
| 3 | Font Selection | | | | | √ |
| 4 | Text legibility | | | | | √ |
| 5 | Background color and text | | | | √ | |
| 6 | The accuracy of the menu layout | | | √ | | |
| 7 | Efficiency | | | | √ | |
| 8 | Effectiveness | | | | √ | |
| 9 | E-learning naming system | | | | | √ |
| 10 | Navigation | | | | | √ |
| 11 | Menu Selection | | | | √ | |
| 12 | Material delivery | | | | √ | |
| 13 | E-learning management | | | | √ | |
| 14 | E-learning in independent learning support | | | | √ | |
| 15 | Internet access | | | | √ | |
| 16 | E-learning login | | | | | √ |
| 17 | Hyperlink | | | | √ | |
| 18 | Innovation | | | | √ | |
| 19 | Benefits for future E-learning development | | | | | √ |
| 20 | Software selection | | | | √ | |
| | Percentage | | | | 86% | |

*5) Material feasibility test*

In this research, research material testing is also needed to see the feasibility of the learning material. The learning material contains a conceptual knowledge of physics [46]. Material experts carried out testing using a questionnaire intended to see the quality of the material from the material expert's view [47]. Table 7 shows that the PLMS application scored 47 out of 55, representing an 85.45% presentation level. The PLMS application is classified in the "very good" category, indicating a high material quality suitable for research and learning purposes.

Table 7. Material feasibility test results

| No | Indicator | Assessment Criteria | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| 1 | Learning materials contextuality | | | | √ | |
| 2 | Learning materials actuality | | | | √ | |
| 3 | Learning materials' compatibility with learning indicators | | | | | √ |
| 4 | The learning material's compatibility with the Curriculum | | | | | √ |
| 5 | The material's compatibility with the learning objectives | | | | | √ |
| 6 | The discussions compatibility in the learning material | | | | √ | |
| 7 | The clarity of the examples in the learning material | | | | √ | |
| 8 | The clarity of the simulation in the learning material | | | | √ | |
| 9 | The clarity of the exercises in the learning material | | | | √ | |
| 10 | The learning material's depth | | | | √ | |
| 11 | Video presentation of the material | | | | √ | |
| | Percentage | | | 85.45% | | |

*6) Usability test*

At this stage, the test system is deployed at the selected schools where the research is being conducted. Specifically, the system is implemented at two senior high schools, involving teachers and students as the primary users. The objective is to observe and evaluate user responses in accordance with the ISO-9126 standard on Usability [48]. It plays a significant role in determining the level of user satisfaction while browsing the web. In line with ISO-9126 guidelines, the usability tests were conducted on teachers and students. Its guidelines recommend a minimum of eight users for its testing. However, for quantitative research aimed at testing usability, a larger sample size of at least 20 respondents is typically required [49]. So based on this basis, the researchers used 78 students as respondents to implement the test system and usability were carried out on two types of respondents, namely teacher and student responses. The following are the results of the two usability tests carried out on teachers and students, which can be seen in Table 8.

Table 8. Usability test results

| Aspects of Usability Evaluation | Percentage | Comment/Suggestion |
|---|---|---|
| Teacher | 96.67% | The system is well-suited for physics learning |
| Student | 98.43% | - |

The usability test findings of the teacher in Table 9 indicate an overall score of 96.67%, placing it in the 'very good' category. Table 10 shows that student respondents scored 98.43%, falling within the 'very good' category. Both teacher and student users exhibited results in the "very good" category, confirming the system's usability effectiveness.

### C. Discussion

The development process of the PLMS application in this research has proceeded according to plan. Utilizing the ADDIE (Analysis, Design, Development, Implementation, Evaluate) model, each step has been meticulously executed and documented. This includes a thorough analysis of the needs of teachers and students, particularly in terms of user access rights.

Table 9. Usability test result of teacher

| | No | Statement | Percentage |
|---|---|---|---|
| Accessibility | 1 | The system is user-friendly | 100% |
| | 2 | Users can easily operate the system | 100% |
| Functionality | 3 | The system features a well-designed layout, enhancing its usability | 100% |
| | 4 | The system facilitates the implementation of distance learning | 100% |
| | 5 | The system contributes to enhancing users' preparedness for distance learning | 100% |
| Performance | 6 | The system incorporates easily understandable and operable buttons | 100% |
| | 7 | This system is organized and practical in its design | 100% |
| Attractiveness | 8 | I feel comfortable using this system | 100% |
| | 9 | I would be keen to utilize this system again | 80% |
| | 10 | This system has an appealing interface | 100% |
| | 11 | This system serves a practical purpose | 80% |
| | 12 | Utilizing this system can encourage users to engage in remote studying | 100% |

Table 10. Usability test result of student

| | No | Statement | Percentage |
|---|---|---|---|
| Accessibility | 1 | The system is user-friendly | 100% |
| | 2 | Users can easily operate the system | 100% |
| Functionality | 3 | The system features a well-designed layout, enhancing its usability | 98.33% |
| | 4 | The system facilitates the implementation of distance learning | 98.89% |
| | 5 | The system contributes to enhancing users' preparedness for distance learning | 97.78% |
| Performance | 6 | The system incorporates easily understandable and operable buttons | 98.89% |
| | 7 | This system is organized and practical in its design | 98.33% |
| Attractiveness | 8 | I feel comfortable using this system | 98.33% |
| | 9 | I would be keen to utilize this system again | 97.78% |
| | 10 | This system has an appealing interface | 97.78% |
| | 11 | This system serves a practical purpose | 97.22% |
| | 12 | Utilizing this system can encourage users to engage in remote studying | 97.78% |

PLMS is a learning application that offers greater flexibility and a wide range of customization options compared to other LMS platforms such as Canvas and Blackboards. This application is specifically developed for physics learning, ensuring that the content and teaching methods are aligned with physics materials. Additionally, it provides ease in uploading learning materials tailored to the characteristics of physics content and the individual needs of learners. This is a significant advantage of PLMS as it has the capability to display learning materials and assignments based on teacher management. The application limits the opportunity for students to resubmit their assignments multiple times to prevent cheating and plagiarism in their work. Moreover, PLMS features an appealing interface designed to align with the characteristics of physics content, thereby motivating students to engage more actively in learning physics.

In this research, the system was evaluated using the ISO/IEC 9126 appropriateness standard. According to ISO/IEC 9126, an entity is defined as having capabilities that can fulfill indicated demands. It's important to note that the adoption of the ISO-9126 standard does not solely depend on the overall features of a website. Instead, the analysis focuses on specific capabilities and functionalities of the system that contribute to meeting user demands and requirements. By employing the ISO/IEC 9126 standard, researchers can conduct a thorough examination of the system's suitability, effectiveness, and overall quality in meeting user needs [50]. This means that the system can be declared valid, even only on some aspects of the assessment. In this study, to ensure the quality and suitability of the Physics Learning Management System (PLMS), a feasibility and usability test are conducted. The feasibility test has been limited to only four aspects including functionality, probability, media feasibility test, and material feasibility test. The usability test involves testing the PLMS application based on feedback from users.

Based on the results of the Functionality Test, it is evident that the developed system has achieved a high level of performance, falling within the "very good" category according to the Likert scale. Specifically, the system received scores of 84.70% for admins, 81.17% for teachers, and 83.63% for students. This is supported by research [51] on evaluating the quality of monitoring web applications using the ISO/IEC 9126 software testing model on the results of the functionality test, which received a score of 76.55%, falling into the satisfactory category with a range of 60%−100%. So that in this research PLMS application was feasible for functionality testing.

The probability testing conducted on the PLMS application system aimed to assess its adaptability across different environments, particularly its compatibility with various desktop and mobile browsers. The results of the probability test indicated that the system can be effectively executed on desktop browsers such as Mozilla Firefox, Google Chrome, Microsoft Edge, and Opera Mini. Similarly, on mobile browsers, the system demonstrated compatibility with browser programs like Google Chrome, Opera Mini, and the UC browser. Based on these findings, it can be concluded that the PLMS application system is feasible in terms of probability testing. The system has shown its ability to adapt to diverse browser environments, both on desktop and mobile platforms. This aligns with the objectives of the research and underscores the system's versatility and accessibility across different user devices and browsing preferences. This is in line with the research [52] entitled ISO/IEC 9126 quality model for evaluation of student academic portal, where the research describes testing on the probability aspect that can run without any errors. It means that the probability quality is good because the application can run on the browser without experiencing errors.

The results of the media expert validity test revealed a percentage of 86%, indicating that the PLMS application system is highly viable as a learning medium according to

media experts. This aligns with the Likert scale, where a range of 80% to 100% falls into the "very good" category. The PLMS application system is classified as "very good" based on this study. Similarly, the analysis based on the feasibility test by material experts yielded a percentage of 85.45%, indicating that the materials used in the PLMS application system are of excellent quality, practical, and suitable for research and learning purposes. This also corresponds to the Likert scale, where a score of 80% to 100% is considered very good.

The usability test evaluates the software's capacity to be understood, learned, utilized, and appealing to users in specific situations. In the case of the online-based test system, both teacher and student assessments yielded results in the "very good" category. Specifically, 96.43% of teacher respondents and 98.4% of student respondents rated the system highly. These findings indicate that the system is easy to understand, learn, use, and engaging.

In summary, the developed PLMS holds the potential to facilitate blended learning models effectively. Its contribution extends to enhancing the understanding of tools supporting blended learning activities and opening avenues for future research. Teachers can utilize the PLMS as a tool to support physics learning and analyze student engagement with technology-driven blended learning activities. Additionally, the PLMS can aid in implementing blended learning models in physics education and identify challenges faced by both teachers and students, including (i) participation in blended learning, (ii) utilization of technology tools, and (iii) the impact on physics learning outcomes.

### *D. Limitations and Implications*

This study has several limitations that must be considered. Firstly, it was limited to developing and evaluating PLMS applications in the context of physics education, which limits the generalizability of the findings. Secondly, the depth and completeness of the research process and results may have been affected by limited resources such as time, funds, and access to expertise. Third, the evaluation of the PLMS relies heavily on expert and user judgments, which may introduce bias in assessing the system's effectiveness. Fourth, the app's affordability testing was conducted only on a limited number of browsers and devices, so potential technical issues in other environments or with evolving technologies have not been fully identified. Finally, affordability testing covered only certain aspects, such as functionality, likelihood, media validity, and material affordability, while security, scalability, and long-term sustainability may need to be adequately covered. Therefore, the results of this study should be interpreted with caution due to the subjective nature of the assessments conducted and the potential biases associated with them. However, the PLMS application can support technology-based learning models in physics education. These findings can inform the development and evaluation of similar systems in other educational areas. Additionally, the findings emphasize the necessity for additional research into the difficulties of implementing technology-based learning models and their effect on learning outcomes. In addition, this research will contribute to a better understanding and optimization of the effectiveness of PLMS and similar systems.

## IV. Conclusion

In conclusion, this study has successfully developed a Physics Learning Management System (PLMS) solution to facilitate Blended Learning at the Senior High School level, utilizing the ADDIE development stages (Analysis, Design, Development, Implementation, Evaluate). The feasibility of the system was rigorously tested in accordance with the ISO-9126 standard. The results of the feasibility test revealed high percentages in the Functionality aspect, indicating smooth system operation. Additionally, the Probability aspect demonstrated the system's compatibility with various browsers, both on mobile and desktop platforms. The media and material feasibility aspects received a very good quality rating, affirming the suitability of the application as a learning medium to support Blended Learning. Furthermore, the usability test indicated that the system is easy to comprehend, learn, and use, while also being engaging for users. Overall, these findings underscore the effectiveness and practicality of the PLMS solution in facilitating Blended Learning in physics education at the senior high school level.

## Conflict of Interest

The author declares no conflict of interest.

## Author Contributions

The study was conceptualized and reviewed by Yul Ifda Tanjung, who also supervised data extraction, drafted the manuscript, and assisted with result interpretation. Festiyed and Skunda Diliarosta contributed to conceptualization, conducted statistical analyses, assisted with data extraction, and co-wrote the manuscript. Asrizal and Muhammad Aizri Fadillah facilitated manuscript revision and led result interpretation. Asrizal and Fitri Arsih conducted final editing of the article, while Muhammad Aizri Fadillah contributed to statistical analyses and data extraction. Muhammad Aizri Fadillah also provided support for statistical analyses and data extraction. All authors reviewed and approved the final manuscript.

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