

Designing a Web-Based LMS at SMKN 4 Serang Using Express.js

Dody Naufal^{1*}, Sigit Auliana², Gagah Dwiki Putra Aryono³

^{1,2,3} Universitas Bina Bangsa, Indonesia

¹dody.naufal@gmail.com, ²pasigit@gmail.com, ³gagahdpa@gmail.com



*Corresponding Author

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ABSTRACT

The rapid advancement of digital technology in the education sector has transformed the learning process to become more efficient, flexible, and accessible. One of the innovations that support this transformation is the Learning Management System (LMS), which facilitates digital-based learning and improves interactions between teachers and students. However, SMKN 4 Kota Serang has not yet implemented an integrated LMS platform, resulting in limited support for Grade XII students in preparing for their final examinations. This research aims to design and implement a web-based LMS application using the Express.js framework to address these challenges and support digital learning needs. The development process follows the Waterfall methodology, which includes several sequential stages: requirement analysis, system design, implementation, testing, and maintenance. Data collection methods include observation, interviews, and literature studies to understand user needs comprehensively. The resulting system offers core features such as digital material management, assignment submission and grading, and a discussion forum to support structured communication between users. With the implementation of Express.js, the LMS application is developed to be fast, lightweight, and scalable, making it suitable for the school's environment. This system is expected to assist both teachers and students in conducting learning activities more effectively and efficiently. Overall, this research contributes to improving the quality of digital learning at SMKN 4 Kota Serang and provides a foundation for further system development in the future.

INTRODUCTION

With rapidly advancing technology in every sector of society, people now utilize information technology as a support for their daily activities—whether in the fields of economy, social affairs, culture, education, health, and so on.

Information technology has grown significantly in today's era of globalization. The development of technology is greatly supported by the presence of the internet, enabling people to use it to assist in various activities such as data management to obtain the necessary information. Along with technological advancements, various applications have been created to help with human tasks. Technological developments in the field of education have greatly assisted educators such as teachers and lecturers in quickly accessing and collecting learning materials. These advancements are also felt by students, from school children to university students, as they can obtain materials and understand lessons more easily.

Technology is now not only used in everyday life but also widely applied in the business sector and even in education. In the field of education, technology is used for various purposes, such as online classes, sharing learning materials, online tutorials, and more. One example of the use of technology in education is the Learning Management System (LMS).

However, with hundreds of millions of websites available, internet users must be more selective in obtaining information and verifying its sources. Many situations occur—for example, new students or senior students often struggle to find learning materials that were previously taught by their teachers, as it is rare to find content that exactly matches what was delivered in class. Therefore, a platform is needed to serve as a repository for the learning materials provided by teachers.

This study aims to assist and enhance student engagement in learning, which is a key component in the teaching and learning process. Media can be utilized by teachers according to students' needs. As stated by (Usman et al., 2024) the Learning Management System (LMS) media can be used by students for independent learning to develop their discussion skills and self-directed learning abilities.

One method that can be used to store and organize learning materials is the Learning Management System (LMS). The portable nature of LMS media allows students to access and review the material repeatedly, anytime and anywhere, which is expected to enhance learning motivation and help instill a strong understanding of concepts. According to research (Wiragunawan, 2022), a Learning Management System (LMS) is essentially a software-based platform designed to manage all learning activities in an educational institution in a structured and integrated manner, including planning, implementing, and evaluating learning.



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The rapid development of information and communication technology has brought changes to various fields, including education. Today, many educational institutions utilize technology as a supporting tool in the learning process. One of the technologies that has evolved is the Learning Management System (LMS), a digital platform that enables more structured and efficient management of learning. LMS provides convenience for both students and teachers in accessing materials, conducting exams, and monitoring learning progress. Similarly, as stated in research (Wiragunawan, 2022) LMS offers several advantages, such as being accessible at any time according to the student's availability and allowing learning from anywhere, making the learning process more flexible.

The existence of a web-based LMS offers many benefits. From the students' perspective, it simplifies access to learning materials, assignments, and grades online. From the teachers' perspective, it allows for more organized management of materials and assignments. Similarly, as stated in research (Aziz, 2024), the Learning Management System (LMS) serves as a practical solution for managing learning activities, distributing materials, and facilitating collaboration.

SMKN 4 Kota Serang, as one of the vocational high schools, has a mission to prepare 12th-grade students to be competitive in the workforce while also succeeding in their final exams. However, the current learning process at SMKN 4 Kota Serang still faces several challenges. One of the main issues is the limited access to relevant learning materials. Most of the learning is still conducted conventionally through face-to-face methods, which are often constrained by time and place. In addition, communication between teachers and students regarding assignment management and discussions is often ineffective due to the lack of a centralized platform that supports such interactions.

Learning at SMKN 4 Kota Serang, particularly for 12th-grade students, still faces challenges in accessing digital materials, managing assignments, and facilitating communication between teachers and students. The absence of an integrated system that supports technology-based learning at SMKN 4 Kota Serang has led to an inefficient and suboptimal learning process. A system is needed to help students prepare for final exams and improve the overall quality of education.

A Learning Management System (LMS) is one of the modern solutions for today's education system. With the implementation of electronic-based learning, the teaching and learning process can become more varied. However, several schools, including SMKN 4 Kota Serang, still face challenges in providing an optimal learning platform. SMKN 4 Kota Serang requires a web-based LMS that is accessible, flexible, and capable of accommodating students' learning needs. In this context, designing a web-based LMS using the Express.js framework is considered effective due to its high performance and ease of implementation. As stated in research (Aziz, 2024) the goal is to enhance the use of technology in the teaching and learning process while providing convenience.

The implementation of an LMS at SMKN 4 Kota Serang requires careful planning based on a user needs analysis. This study focuses on designing a web-based LMS using the Express.js framework. The system is designed with an emphasis on ease of use, fast access, and features that align with the learning needs of 12th-grade students.

Express.js is one of the technologies that can be used to develop web-based applications. This framework offers speed, flexibility, and ease in building scalable backend applications. In the context of this study, Express.js will be used to design a web-based LMS that supports the learning of 12th-grade students at SMKN 4 Kota Serang. According to (Mulana et al., 2022) Express.js is known for its speed and flexibility, meaning it can handle multiple requests simultaneously without slowing down.

This research is expected to make a meaningful contribution in supporting the education of 12th-grade students at SMKN 4 Kota Serang. Additionally, the results of this study are expected to serve as a reference for developing LMS applications in other educational institutions facing similar challenges. By utilizing modern technologies such as Express.js, this research focuses not only on system development but also on providing innovative solutions to improve the quality of education in the digital era.

LITERATURE REVIEW

The literature review was carried out by the author to establish a theoretical foundation and support for the research activity, which is the development of a Web-Based Learning Management System (LMS) application for Grade XII students of SMKN 4 Kota Serang using the ExpressJS framework. Based on the reviewed literature, the author refers to previous studies, thus categorizing this research as a system development study using the waterfall model (Haniva et al., 2023).

The author explored various studies that discuss Learning Management Systems (LMS). From the analysis conducted on previous research, it can be concluded that the development of web-based LMS has proven effective in enhancing accessibility, efficiency in learning management, and interaction between students and teachers. The majority of the studies employed the System Development Life Cycle (SDLC) using the Waterfall model, along with various system design tools such as UML, DFD, ERD, and testing methods such as Black-box Testing (Fachri & Surbakti, 2021).

METHOD

Type of Research

This study is a system development research aimed at designing a web-based Learning Management System (LMS) application for 12th-grade students at SMKN 4 Kota Serang using the Express.js framework. This research adopts a software engineering approach, with systematic stages based on the Waterfall development model.

The Waterfall model was chosen because it offers a structured workflow, starting from requirements analysis to the maintenance phase. Each stage is completed before moving on to the next, allowing for better control over the system development process. This model has also been widely used in previous research related to LMS development, such as in (Usman et al., 2024), which applied the Waterfall model to design an LMS system and succeeded in improving accessibility and learning efficiency.

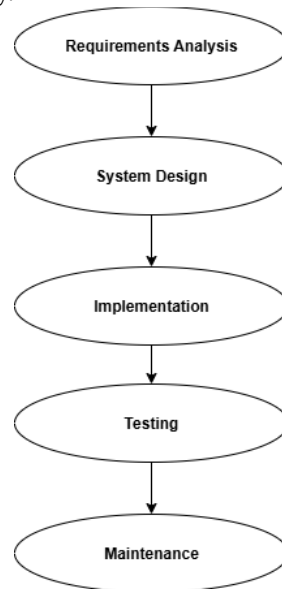


Figure 1. Conceptual Framework of the Web-Based LMS System

Moreover, this study emphasizes the importance of aligning the LMS design and features with the needs of its users, namely teachers and 12th-grade students. This aligns with the software engineering approach that places users at the center of the development process. In this context, the LMS is designed to overcome the challenges of conventional learning, such as limited access to materials and a lack of effective interaction between teachers and students. According to (Aziz, 2024) the implementation of a web-based LMS facilitates material distribution and increases the efficiency of online learning management.

System Development Method

The model used in this system development is the Waterfall method, which consists of several stages, namely:

Requirements Analysis, This stage aims to identify the system's functional and non-functional requirements through observations and interviews with school staff, teachers, and students. Key requirements include the management of learning materials, exams, assessments, teacher-student communication, and learning outcome reporting (Bayu, 2023).

The analysis was conducted using a combination of literature review, direct observation, and in-depth interviews. Based on the interview results, it was found that teachers faced difficulties managing assessments manually, while students wanted access to materials that could be reviewed at any time. Therefore, features such as digital content management and discussion forums became essential components of the system requirements. As explained in the documentation, the LMS must offer ease of access, material portability, and efficient learning processes to meet the needs of users at SMKN 4 Kota Serang

System Design, After understanding the system requirements, the system design phase was carried out, which includes application architecture design, user interface (UI/UX) design, and database structure design. This design takes into account system accessibility and flexibility to suit the conditions at SMKN 4 Kota Serang.

During the design process, the system was developed as a web-based application to ensure it can be accessed anytime and anywhere. The user interface was created to be as simple as possible, making it user-friendly for both students and teachers. The design adopts a user needs-based approach identified in the previous phase. This study exemplifies the implementation of user-centered design principles, as demonstrated in the research by (Syuhada & Handrianto, 2023), which emphasizes the importance of implementing responsive and efficient interface designs to support online learning.



Implementation, In this stage, the system is coded using the Express.js framework. This framework was chosen due to its advantages in performance and efficiency. According to (Hadinata & Stianingsih, 2024), the average response time of Express.js is 48.68 ms faster compared to the Laravel framework.

The advantages of Express.js lie not only in its speed but also in its flexibility for developing scalable backend systems. Additionally, Express.js simplifies integration with databases and other APIs required in an LMS. A study by (Mulana et al., 2022) further supports this, stating that Express.js has a better average response time compared to CodeIgniter, making it an ideal solution for high-demand systems like an LMS.

Testing, Testing is conducted to ensure that the LMS application functions as expected. The testing covers aspects such as functionality, user interface, and system security.

The system is tested using the **black-box testing** method to evaluate whether all key features such as material uploads, task management, and discussion forums work properly without errors. Another study by (Saragih & Silalahi, 2024) also used this method to evaluate a web-based LMS and demonstrated its reliability in ensuring system performance without directly testing the source code.

Maintenance, The final stage includes documentation, user training, and system improvements based on user feedback.

Maintenance is carried out continuously to ensure the system remains relevant and capable of meeting user needs. This includes updating learning content, fixing bugs, and developing additional features based on input from teachers and students. User training is also a top priority, as mentioned in the documentation—one potential challenge is the need for training to ensure users can operate the LMS effectively.

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Data Collection Techniques

Literature Study, This involved analyzing journals, articles, and previous research relevant to the development of web-based LMS using Express.js. The purpose of this study was to understand the fundamental concepts of Learning Management Systems, the strengths and weaknesses of various LMS platforms, and best practices for implementing similar systems in other educational institutions.



Through this literature study, the researcher was also able to identify research gaps that have not been widely explored, such as the use of the Express.js framework in developing LMS for vocational high school education. Research by (Hoque, 2020) indicates that Express.js offers advantages in response speed and resource efficiency compared to other frameworks like Laravel, making it highly relevant to the learning needs at SMKN 4 Kota Serang.

Observation, Direct observation was conducted on the learning system currently implemented at SMKN 4 Kota Serang, particularly for 12th-grade students. This observation aimed to obtain a factual understanding of the teaching methods used, available learning media, and the challenges faced by teachers and students in conventional teaching and learning processes.

The results showed that the learning process remains manual and has yet to be digitally integrated. Teachers prepare materials in printed form, and students receive and submit assignments physically. The use of digital tools such as projectors is still limited, and there is no centralized system to support continuous interaction between teachers and students. This highlights the urgency of developing an LMS designed to simplify material access and assignment management online.

This situation is consistent with the findings of (Sudradjat, 2020), which state that conventional learning with minimal use of information technology tends to be ineffective in meeting the needs of today's digital generation. Limitations in accessing materials, rigid learning schedules, and a lack of interactive media hinder improvements in the quality of education. Therefore, the integration of digital systems such as a Learning Management System (LMS) is seen as a strategic step to overcome these obstacles and create a more adaptive and collaborative learning environment.

Interviews, Interviews were conducted with teachers and students to gain deeper insights into the challenges they face and their expectations for the system to be developed. These interviews included questions about the delivery of learning materials, assessment methods, communication, and the learning media currently in use.

The interviews revealed that teachers experienced difficulties in efficiently compiling grades, while students reported challenges in reaccessing previously taught materials. Both parties responded positively to the idea of using an LMS, viewing it as a solution to overcome the limitations of time and location in the learning process. Additionally, they expressed a desire for features such as online discussions, online exams, and downloadable materials—similar to those implemented in the study by (Wiragunawan, 2022), which successfully improved learning efficiency through the developed LMS.

Analysis of the Current System

System analysis was conducted to evaluate the condition of the current manual learning system, starting from the preparation of lesson plans (RPP), assignment collection, to student assessment. The analysis used a SWOT approach to identify the strengths, weaknesses, opportunities, and threats of the system.

The SWOT approach provides a comprehensive overview of the system being designed. The strengths of this web-based LMS include ease of access, material portability, and efficiency in learning management. The LMS enables students to study anytime and anywhere, while also offering flexibility for teachers to deliver content and monitor student progress. This aligns with the analysis findings, which indicate that web-based systems can accelerate the teaching process and improve the efficiency of teacher-student interactions.

On the other hand, the identified weaknesses include limited infrastructure, particularly uneven internet access, as well as the need for training for teachers and students to operate the system effectively. Additionally, the main threats involve data security and reliance on technology such as servers or electricity. To anticipate these weaknesses and threats, solutions such as user training, cloud integration, and data protection through encryption and regular backups must be carefully planned. According to the documentation, the system should also be designed to remain competitive and capable of rivaling existing commercial LMS platforms by offering superior features.

Conceptual Framework

The conceptual framework in this study illustrates the logical flow from problem identification, needs analysis, system design, to implementation and evaluation. These stages are visualized in Figure 1 in the previous document as part of the waterfall methodology.

The first stage begins with needs analysis, which involves identifying the key features required in the LMS based on interviews and direct observations of teachers and twelfth-grade students at SMKN 4 Kota Serang. Once the requirements are gathered, the process continues to the system design phase, which includes frontend and backend design, database structure, and user interface (UI/UX) design to ensure the system is user-friendly. According to the document, this design aims to ensure that the system being developed aligns with field needs and supports structured and independent learning.

Next, the system is developed using the Express.js framework, which is known for its speed and lightweight performance in backend application development. The use of Express.js is supported by previous studies stating that this framework has a faster response time and more efficient resource usage compared to other frameworks such as Laravel and CodeIgniter (Hadinata & Stianingsih, 2024) and (Mulana et al., 2022). After implementation, testing is conducted to ensure all functions work according to user needs. Finally, the maintenance stage includes system



evaluation based on user feedback, as well as the development of additional features if needed in the future.

RESULT

LMS System Design Results

This study produced a web-based Learning Management System (LMS) designed specifically for twelfth-grade students at SMKN 4 Kota Serang. The system was developed using the Express.js framework for the backend and HTML, CSS, and JavaScript for the frontend. It is designed to meet digital learning needs such as content management, assignments, quizzes, and discussion forums.

The design process began with a needs analysis, which involved interviews with students, teachers, and administrators to determine the core features required. This process identified essential needs such as digital content management, discussion forums, online exams, and an integrated grading system. Technical requirements were also taken into consideration, including data security, responsiveness across various devices, and access efficiency.

The system design was carried out after gathering input from three key user groups: students, teachers, and administrators. The main features required include learning content management, assignment submission, online quizzes, discussion forums, and an integrated assessment system. This process is illustrated in the Proposed System Flowchart below.

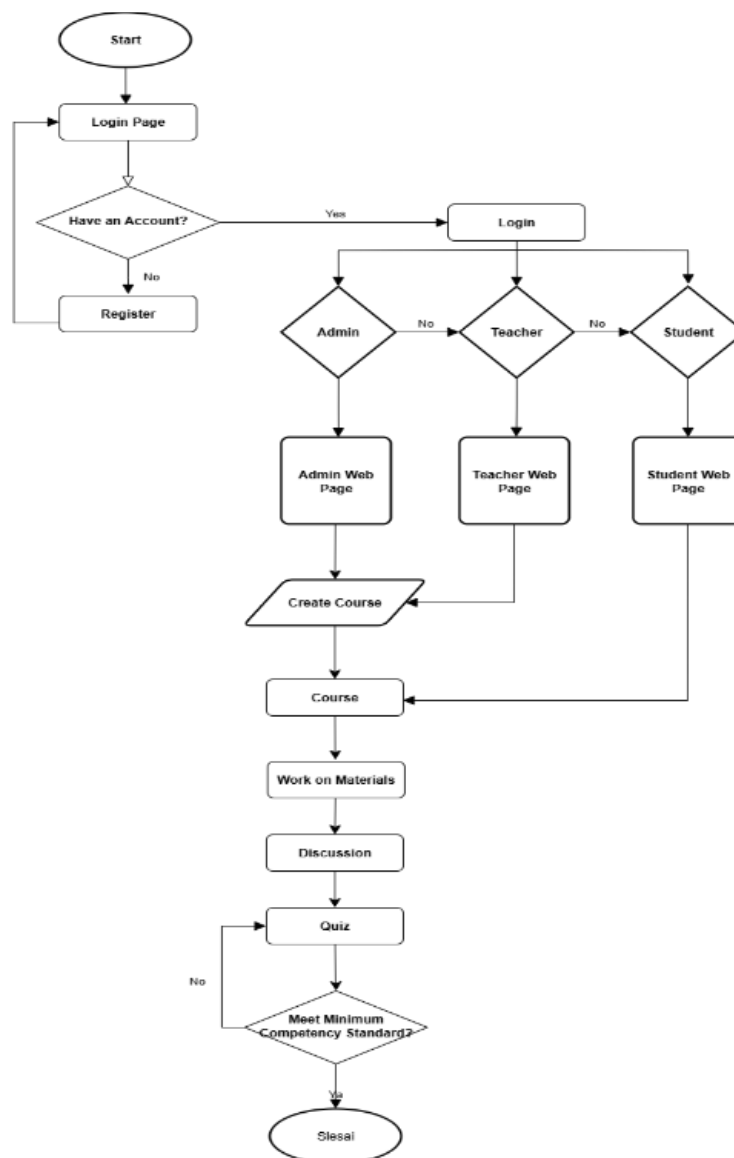


Figure 2. Flowchart of the Learning Management System (LMS)

System Implementation

The system consists of several main components: admin, teacher, and student dashboards, each equipped with features tailored to their respective roles. Admins can manage user accounts and create courses; teachers can upload learning materials, assign tasks, and grade results; while students can access materials, participate in discussions, and



complete assigned tasks or quizzes. The system workflow is visualized through flowcharts, use case diagrams, and activity diagrams that detail the interactions between users and the system.

The database was designed using normalization up to the third normal form (3NF) to ensure data integrity. Stored data includes user information, learning materials, assignments, assessment results, and user activity within the system. The technical specifications include the use of SSD storage media, along with role-based access control separating permissions for students, teachers, and admins to enhance system security and management.

Below is the Use Case Diagram illustrating the interactions between users and the system:

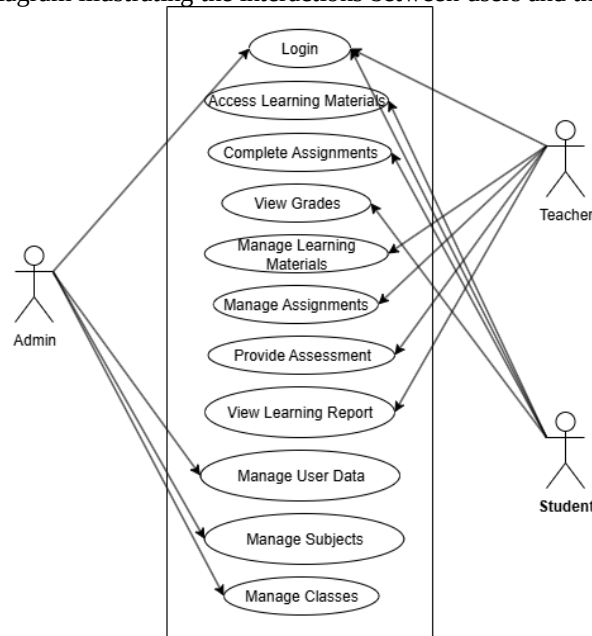


Figure 3. Use Case Diagram of the Web-Based LMS Application

This diagram illustrates how each role has different access rights and limitations within the system. For example, teachers are only authorized to create and grade assignments, while students can only complete assignments and view their results.

To provide a more detailed depiction of system activities, the following is the Activity Diagram of the main processes within the LMS:

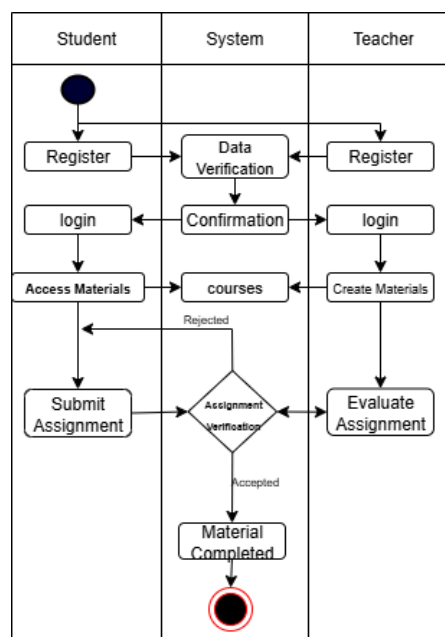


Figure 4. Activity Diagram of the Web-Based LMS Application

This activity diagram illustrates that the interaction begins with login, after which users are directed to activities based on their roles: accessing or uploading materials, completing or reviewing assignments, and the validation process handled by the system.

System Testing Results

Testing was carried out using two methods: black box testing and white box testing. In the black box testing, features such as login, uploading materials, accessing content, and submitting assignments were tested based on the expected input-output. The results showed that all features functioned as expected, although several limitations were identified, such as excessively large file sizes or duplicate file names that could be overwritten if not properly managed.

According to (Fikri et al., 2022) the black box method is capable of identifying errors in functions, data models, data access, and interfaces. The results of the testing process can be used as evaluation material and improvements to enhance the quality of the information system being developed.

Table 1. Black Box

Tested Feature	Input	Expected Output	Status
Student Login	Valid username & password	Redirected to student dashboard	Match
Failed Login	Incorrect username/password	Message "Incorrect username or password"	Match
Upload Material	Valid PDF/video file	File appears on student page	Match
Access Student Material	Click material	Material is displayed/available for download	Match
Submit Assignment	Valid assignment file	Assignment is sent and appears on teacher's dashboard	Match

White box testing was conducted to examine the application's logic structure and security. The system utilizes bcrypt for password encryption and includes robust input validation. However, the evaluation revealed a need to implement additional features such as rate-limiting and CAPTCHA to enhance security, as well as optimization for uploading and downloading large files.

According to (Praniffa et al., 2023), white box testing offers several advantages, such as the ability to eliminate foreign or hidden parts of the code, conduct comprehensive testing by exploring all aspects of logic and structure, assist in code optimization, and allow testing to begin even if the GUI is still under development.

DISCUSSION

Evaluation and Discussion

System evaluation was carried out to assess the extent to which this LMS application addresses the learning issues previously experienced at SMKN 4 Kota Serang. The results indicate that the system successfully improved efficiency in managing learning materials, assignment submissions, and teacher-student interaction. Significant differences between the conventional system and the LMS can be observed in terms of learning media, access flexibility, and the automation of assessments, which were previously performed manually.

Furthermore, the implementation of an LMS based on **Express.js** proved to be both effective and efficient. As previously mentioned in the documentation, **Express.js** offers fast response times and low resource usage, making it a suitable choice for medium-scale educational applications such as those at SMKN 4 Kota Serang. This system also supports the principles of self-directed and flexible learning according to students' needs, thereby contributing positively to the quality of the teaching and learning process.

System User Interface Display

The user interface is designed to be simple and intuitive to make it easy for users from various backgrounds to navigate the system. As a complement, the following is an example of the system's user interface:

Login, The initial display of the system begins with the login page, which serves as the main entry point for all users. On this page, users are required to enter their email or username and password for authentication. There is also a link to the registration page for new users who do not yet have an account. The login page is designed with a responsive and minimalist layout to ensure accessibility across various devices.



Figure 5. Login Page Interface of the LMS Application

Register: Next, the registration page is designed to facilitate the enrollment of new users. On this page, users are required to fill in information such as full name, email, password, confirm password, and select their role in the system, whether as a teacher or a student. This page also provides a link back to the login page. With a simple and clear layout, the registration page makes it easy for users from various backgrounds to create their accounts without confusion.

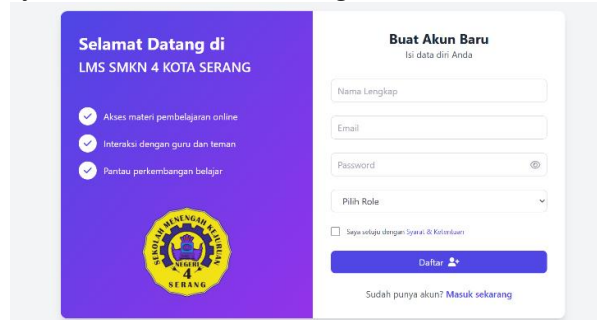


Figure 6. Registration Page Interface of the LMS Application

Admin Dashboard, After successfully logging in, users are directed to the dashboard view based on their selected role. For the admin role, the dashboard presents a layout with a navigation menu on the left side that links to management features such as user management, classes, and learning materials. The main section of the dashboard displays a summary of key data in the form of widgets or information cards, such as the number of teachers, students, and active classes. This interface is designed to provide an overview and quick access to the main administrative functions within the LMS.

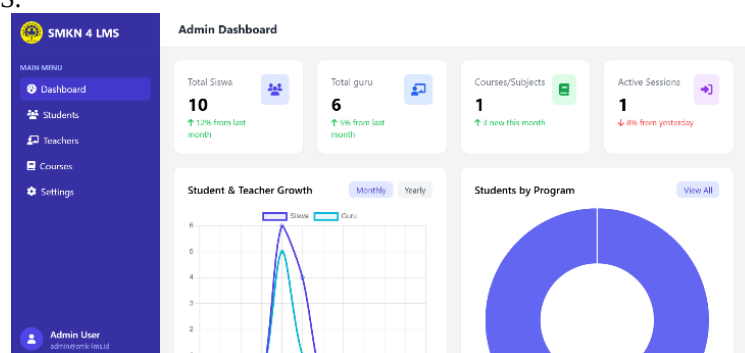


Figure 7. Admin Dashboard Interface of the LMS Application

Teacher Dashboard, Unlike the admin, users with the teacher role will see a dashboard focused on teaching activities. This interface displays a list of classes they are responsible for, along with a navigation menu leading to features such as managing teaching materials, assigning tasks, and evaluating students. The interface is designed to make it easy for teachers to organize learning content and conduct digital assessments of their students

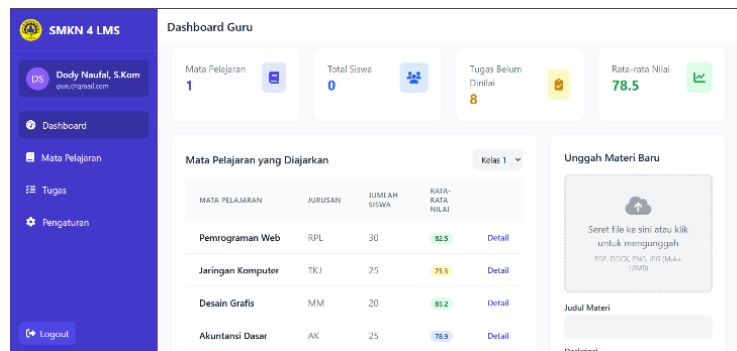


Figure 8. Teacher Dashboard Interface of the LMS Application

Student Dashboard, Meanwhile, the student dashboard is tailored to meet the needs of users in receiving and accessing learning materials. Students can view the list of classes they are enrolled in, access materials uploaded by teachers, and complete assigned tasks. The navigation is designed to be as simple as possible, allowing students to easily understand and use the main features without technical difficulties. This design is intended to support effective and efficient teaching and learning activities in a digital environment.

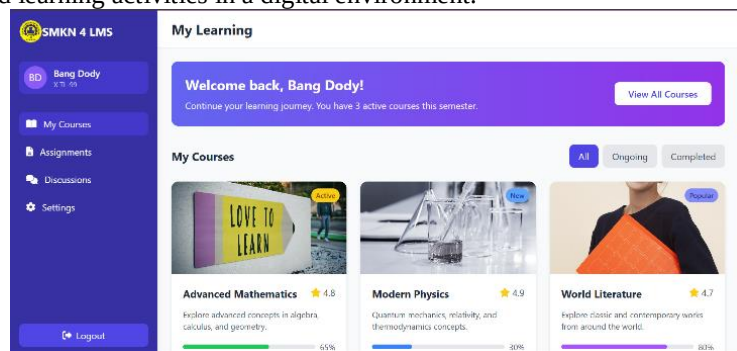


Figure 9. Student Dashboard Interface of the LMS Application

CONCLUSION

This study successfully designed and implemented a web-based Learning Management System (LMS) using the Express.js framework, aimed at supporting the learning process of 12th-grade students at SMKN 4 Kota Serang. The developed system provides a solution to the limitations of conventional learning, particularly in terms of access to materials, assignment submission, and communication between teachers and students.

The development process followed the waterfall method, with systematic stages starting from needs analysis, system design, implementation, testing, and maintenance. The implementation results show that the designed LMS is capable of providing essential features such as digital material management, online quizzes, discussion forums, and an integrated grading system.

System testing using both black box and white box methods demonstrated that the system functions properly and is secure to use. This LMS not only enhances the efficiency and flexibility of the learning process but also strengthens student engagement in self-directed learning activities.

The Express.js framework has proven effective in supporting the system's technical needs due to its speed and scalability. Therefore, this LMS application is expected to serve as an innovative, adaptive, and user-friendly learning platform and could become a development model for similar LMS implementations in other educational institutions.

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