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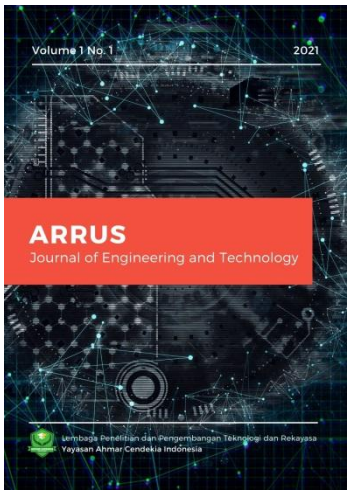

RESEARCH ARTICLE

Designing An E-Learning Application at Sma Negeri 12 Pandeglang to Improve Learning Effectiveness Using Bootstrap Framework and PHP

Gagah Dwiki Putra Aryono* & Ajis Setiawan

Faculty of Computer Science, Bina Bangsa University, Serang City, Indonesia

*Corresponding author: :Gagah Dwiki Putra Aryono, Department of Computer Science, Faculty of Computer Science, Bina Bangsa University, Serang City, Indonesia

E-mail: gagahdpa@gmail.com

Abstract: The advancement of information and communication technology has significantly influenced the education sector, especially in enhancing learning flexibility and accessibility. This study aims to design and develop a web-based e-learning application for SMA Negeri 12 Pandeglang to improve the effectiveness of the teaching and learning process. The development method used is the Waterfall model, consisting of analysis, design, implementation, testing, monitoring, and maintenance stages. The application was built using Bootstrap for responsive and user-friendly interface design, and PHP for server-side development, supported by a MySQL database. Data collection was carried out through observation, questionnaires, and document study to identify existing issues, including limited interaction between teachers and students, manual task management, and inadequate access to learning materials. The system includes features such as user-role-based login, online material upload and download, assignment submissions, and performance reports. Testing using the Black Box method shows that the application functions properly and meets user needs. This se-learning platform is expected to support digital learning transformation and serve as a practical solution for improving educational quality in rural schools.

Keywords: E-learning, Web-based learning system, Bootstrap, PHP, Education technology, Waterfall model

1. Introduction

The development of information and communication technology (ICT) has significantly impacted various sectors, including education. In today's digital era, the need for flexible and integrated learning systems is increasingly important, particularly in supporting distance and blended learning methods. E-learning is one of the technological innovations that addresses these challenges by providing an online learning platform accessible anytime and anywhere by both teachers and students (Almaiah, Al-Khasawneh, & Althunibat, 2020).

In Indonesia, the implementation of e-learning has accelerated, especially since the COVID-19 pandemic forced educational institutions to shift from face-to-face methods to online learning. Although the emergency phase of the pandemic has passed, the need for e-learning platforms

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remains relevant to support more effective and efficient learning processes (Sari, Yudhistira, & Pratama, 2021). However, the major challenge in implementing e-learning at the senior high school level, especially in areas such as Pandeglang Regency, lies in the availability of digital learning systems that align with local needs and the school's infrastructure capabilities.

SMA Negeri 12 Pandeglang, as a public high school in the Pandeglang Regency area, faces challenges in achieving effective learning, particularly in material delivery, task management, and interaction between teachers and students. Based on preliminary observations and interviews with teachers, it was found that learning processes still rely on conventional methods without adequate digital support. This situation has affected the ability to monitor student progress, delayed material distribution, and caused a lack of digital learning archives that students can access (Ministry of Education and Culture, 2020).

The development of a web-based e-learning application offers a strategic solution to improve learning effectiveness at SMA Negeri 12 Pandeglang. By utilizing the Bootstrap framework for responsive and user-friendly interface design and PHP for backend development, the application is designed to be easily accessed across devices, including desktops and mobile phones. Bootstrap enables attractive and adaptive interface designs, while PHP supports dynamic data processing, user authentication, material uploads, and learning activity reports (Ghaleb, 2022).

Several studies have shown that the use of e-learning enhances student learning interest, provides flexibility in accessing materials, and facilitates teachers in monitoring student performance in real-time (Khan, 2021; Nugroho & Sugiyanto, 2023). Moreover, e-learning supports competency-based learning approaches that encourage student independence and responsibility in the learning process. This aligns with the national education goal of fostering lifelong learners who are adaptive to technological developments (Law No. 20 of 2003 on the National Education System).

Therefore, the development of an e-learning application based on Bootstrap and PHP at SMA Negeri 12 Pandeglang is expected to provide not only a technical solution to the existing learning problems but also a strategic step in supporting digital transformation in regional education. This project aims to design an intuitive, user-friendly, and scalable system tailored to the needs of teachers, students, and the school's technological conditions.

2. Literature Review

2.1. *E-Learning*

E-learning is a system or educational concept that utilizes information technology in the teaching and learning process. This system enables interaction between instructors and learners through digital platforms. According to Moore, Dickson-Deane, and Galyen (2011), e-learning encompasses various forms of computer-based learning technologies, including online learning platforms, video conferencing, and Learning Management Systems (LMS). E-learning provides flexibility in time and location, and offers interactive and engaging learning materials.

In Indonesia, e-learning has become increasingly important, especially in the post-pandemic period, which forced educational institutions to adapt to online learning methods (Sari et al., 2021). Well-implemented e-learning can enhance the effectiveness and efficiency of learning, accelerate the dissemination of information, and support students' independent learning styles (Almaiah et al., 2020).

2.2. *Learning Effectiveness*

Learning effectiveness refers to the extent to which educational objectives are optimally achieved. In the context of e-learning, effectiveness is influenced by several factors, such as accessibility,

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content quality, interactivity, and student engagement (Arbaugh, 2014). An effective e-learning system can increase student motivation, encourage active participation, and improve academic performance.

According to Garrison and Vaughan (2008), a blended learning approach that combines online and face-to-face learning has been shown to increase learning effectiveness by leveraging the advantages of both methods. With e-learning applications, teachers can manage classrooms more systematically, while students can access learning materials at any time, supporting continuous learning processes.

2.3. *The Role of Web Technology in Education*

Web technology has become the backbone of e-learning system development. Web-based platforms enable the integration of various learning features, such as material uploads, online quizzes, discussion forums, and learning performance reports. According to Naser (2020), the use of web technology in education makes the learning process more dynamic, collaborative, and adaptive to modern developments.

Web development frameworks such as Bootstrap support the creation of responsive and user-friendly interfaces. This is essential so that the application can be accessed from various devices, including desktops and smartphones, which is crucial for students in today's digital age (Ghaleb, 2022).

2.4. *Bootstrap*

Bootstrap is an open-source framework based on HTML, CSS, and JavaScript used to accelerate the creation of web user interfaces. It provides ready-to-use UI components such as buttons, forms, navbars, and a responsive grid layout (Otieno & Wang, 2021). In e-learning application development, Bootstrap offers advantages in designing clean, modern, and accessible user interfaces across devices.

The use of Bootstrap is highly relevant for the development of the e-learning application at SMA Negeri 12 Pandeglang, considering that most users (teachers and students) are likely to access the system via mobile devices such as smartphones.

2.5. *PHP (Hypertext Preprocessor)*

PHP is a server-side programming language widely used for developing dynamic web applications. PHP is easy to learn, open-source, and highly compatible with various databases such as MySQL, making it suitable for building e-learning systems (Kurniawan & Siregar, 2020). PHP allows developers to build essential modules for e-learning, such as user authentication, material management, assignments, and reporting systems.

Many learning platforms such as Moodle and WordPress LMS are also developed using PHP, which demonstrates the language's maturity and reliability in developing large-scale educational applications.

2.6. *Related Studies*

A study by Nugroho and Sugiyanto (2023) found that web-based e-learning applications significantly improve students' learning motivation and outcomes in senior high schools. Similarly, research by Khan (2021) showed that responsive and user-friendly learning platforms have a strong impact on students' online learning experiences. In this context, using Bootstrap and PHP as the technical foundation is a strategic choice because it supports both interface design and backend logic.

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3. Method

3.1. *System Design Method*

The research method is the approach or technique used by researchers to collect, analyze, and interpret data in order to answer the research questions posed in the study. This method aims to ensure that the results obtained are credible, valid, and accountable.

The method used in this study is the Waterfall model of software development. This model was chosen because it provides a structured and systematic workflow, allowing each development stage to be carried out in an organized and comprehensive manner.

3.2. *Existing System*

The learning system at SMA Negeri 12 Pandeglang still faces various challenges related to teaching methods, teacher-student interaction, task management, and limited technological infrastructure. The teaching and learning process is still predominantly conducted using conventional methods, with direct delivery of materials in the classroom, a lack of structured documentation, and limited communication outside of face-to-face sessions. Assignments and exams are often handled manually, with no real-time monitoring system or automated grading process. Infrastructure limitations, such as the requirement to enter class codes and the lack of reliable devices or internet connectivity, further hinder learning flexibility.

3.3. *Problems in the Existing System*

The analysis results indicate three main issues: the absence of an integrated learning system, difficulties in effective communication outside of class hours, and challenges in monitoring students' learning progress in real time. Therefore, the proposed e-learning system must fulfill several functional requirements, including flexible access to materials, role-based login (admin, teacher, student), online material and assignment upload features, as well as account and report management functions. In addition, the system must also meet non-functional requirements such as user-friendliness, accessibility, and data security.

3.4. *Proposed System*

The implementation of e-learning applications holds great potential to enhance the quality of education in schools. However, achieving success requires strategic steps to address existing challenges. Through infrastructure development, teacher training, content improvement, effective evaluation systems, and parental involvement, e-learning applications can be optimized to support effective and efficient learning processes.

Schools need to conduct regular evaluations of e-learning application usage and involve all stakeholders—teachers, students, parents, and system administrators—in the improvement process. With strong collaboration, this application can become a viable solution for the future of education.

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4. Results and Discussion

4.1. Result

4.1.1. Unified Modeling Language

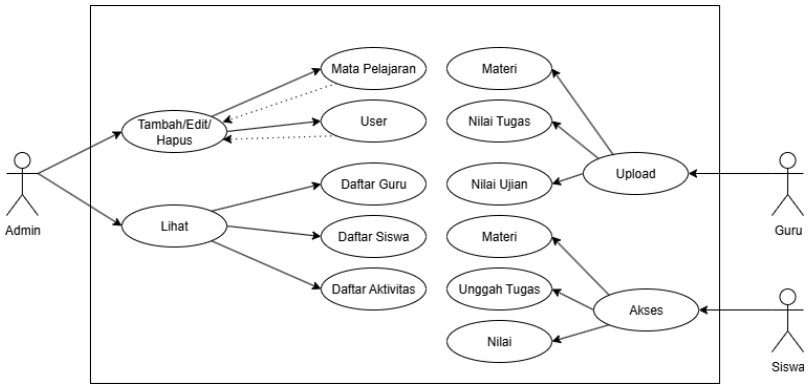

Figure 1. Use Case Diagram

The use case diagram illustrates a role-based interaction model within the e-learning system involving three main actors: Admin, Teacher, and Student. The Admin holds full control over system management, including adding, editing, and deleting data related to subjects and users, as well as monitoring teacher and student activity through features like viewing teacher lists, student lists, and system usage. Teachers primarily interact with the system by uploading learning materials, assignment grades, and exam results, ensuring the delivery and evaluation of academic content. Meanwhile, students access the system to retrieve learning materials, submit assignments, and view their grades. This structured approach ensures each user performs functions appropriate to their role, thereby supporting an organized and efficient digital learning environment.

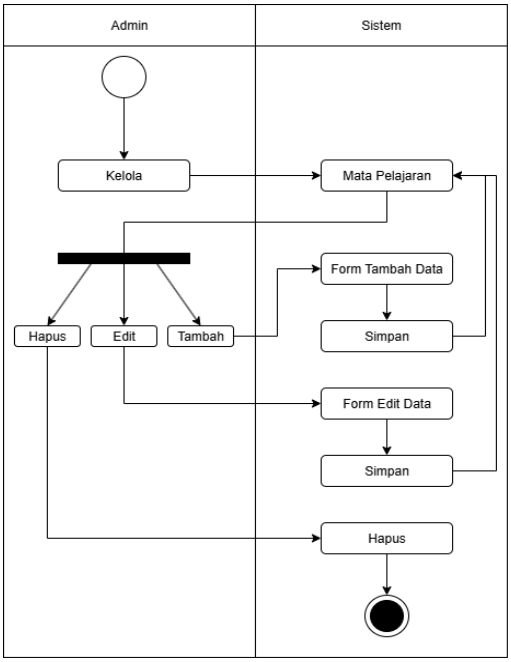

Figure 2. Activity Diagram

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The activity diagram illustrates the process of managing subject data by the Admin within the e-learning system. The process begins when the Admin accesses the "Manage" feature, which leads to the subject management interface. From this point, the Admin can choose one of three actions: Add, Edit, or Delete subject data. If the Admin selects Add, the system displays the Add Data Form, which, once completed, is submitted and saved to the database. If the Admin chooses Edit, the system loads the Edit Data Form, allowing updates to be made and saved. For the Delete action, the system directly executes the deletion of the selected data. After each operation—whether adding, editing, or deleting—the system returns to the updated subject list, maintaining data consistency and ensuring seamless management of educational content.

4.1.2. User Interface E-Learning

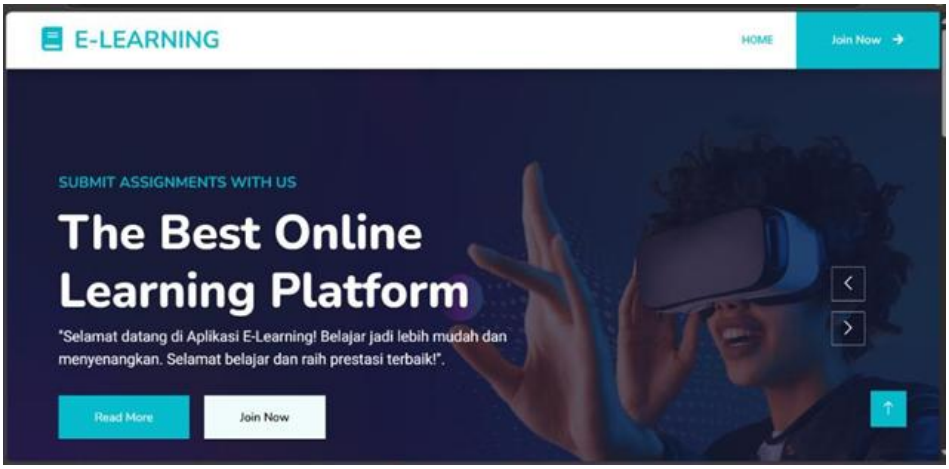

Figure 3. UI Home Page

This page serves as the main homepage for all users and contains an overview of the e-learning application. It provides information about the website/application, including details about the developer, how to use the platform, contact information, location, communication channels, and various engaging instructions or guidance displayed on the page.

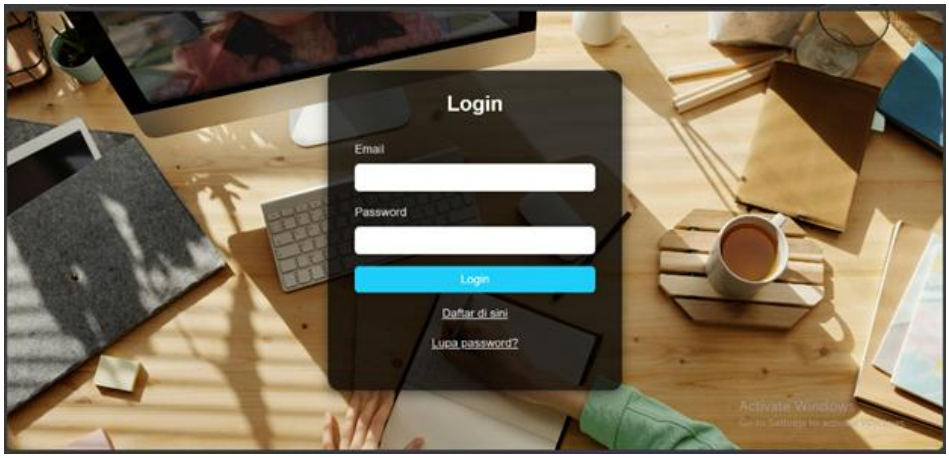

Figure 4. UI Login Page

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This page is the login page for all users to access their respective dashboards based on their roles (admin, teacher, student). On this page, users will be directed to register if they do not yet have an account. If users already have an account, they are encouraged to log in using their registered email address.

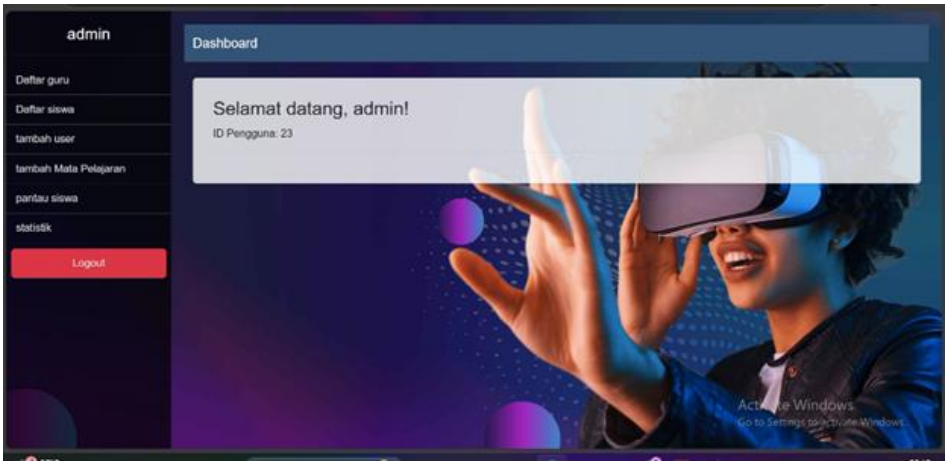

Figure 5. Admin Page

This page is accessed by the admin after successfully logging into the admin dashboard. On this page, several features are available, including teacher list, student list, add user, monitor students, add subjects, and view statistics.

4.2. Testing

After completing the system development stages, the next step is system testing to ensure that the application functions properly and meets user requirements. In this research, two types of testing methods were applied: Black Box Testing and White Box Testing. Black Box Testing focuses on testing the functional aspects of the system without considering the internal code structure. This method evaluates whether the system's inputs produce the expected outputs and whether each feature operates according to the predefined requirements. Black Box Testing was conducted on key functionalities such as login, data input (teacher, subjects, attendance), payroll processing, payslip generation, and report viewing. The results indicated that each feature behaved as expected, validating that the user interface and system responses align with the user workflow. Meanwhile, White Box Testing was performed to examine the internal logic, code structure, and flow of the program. This testing method verifies code execution paths, decision points, and possible loop iterations to ensure there are no logical errors or redundant code segments. White Box Testing was applied during the development phase to check individual modules, especially on payroll calculation functions and database interactions. The outcomes confirmed that all control structures, conditional branches, and loops executed correctly, contributing to system stability and efficiency. In conclusion, both testing approaches demonstrated that the proposed payroll information system performs reliably and effectively, with accurate data processing, minimal errors, and a user-friendly interface that meets the operational needs of MTs Ma'arif 30 Sumber Rejeki Mataram Lampung.

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Table 1. BlackBox Testing

No.	Fungsi	Data Masukan	Hasil yang Diharapkan	Keterangan
1	Validasi Login Admin	Menampilkan form login untuk admin	Aplikasi akan masuk ke dalam halaman dashboard admin	Diterima
2	Validasi Login Guru	Menampilkan form login untuk guru	Aplikasi akan masuk ke dalam halaman dashboard guru	Diterima
3	Validasi Input Data Guru	Menampilkan form tambah data guru	Data guru berhasil tersimpan di dalam database	Diterima
4	Validasi Input Mata Pelajaran	Menampilkan form tambah mapel	Data mapel berhasil disimpan di dalam tabel mapel	Diterima
5	Validasi Input Absensi Manual	Menampilkan form input absensi berdasarkan NIP dan tanggal	Data absensi tersimpan dan status kehadiran tercatat	Diterima
6	Validasi Scan Absensi QR Code	Menampilkan form scan QR code	QR code terbaca, status absensi otomatis tersimpan sebagai Hadir	Diterima
7	Validasi Perhitungan Gaji Guru Mapel	Menampilkan tombol proses hitung gaji berdasarkan jadwal	Gaji dihitung otomatis berdasarkan jumlah mapel dan absensi	Diterima
8	Validasi Cetak Slip Gaji	Menampilkan tombol cetak slip gaji berdasarkan bulan & NIP	Slip gaji ditampilkan dan dapat diunduh sebagai file PDF	Diterima
9	Validasi Rekapitulasi Absensi Bulanan	Menampilkan rekap absensi berdasarkan bulan dan guru	Data absensi bulanan per tanggal ditampilkan dalam bentuk tabel	Diterima
10	Validasi Laporan Absensi	Menampilkan form filter laporan absensi	Laporan absensi dapat di-generate dan diunduh (PDF/Excel)	Diterima
11	Validasi Laporan Gaji	Menampilkan form filter laporan gaji	Laporan gaji guru per bulan dapat diunduh dalam bentuk tabel dan PDF	Diterima

5. Conclusion

Based on the results of the research, analysis, design, implementation, and testing conducted on the web-based Teacher Payroll Information System using the CodeIgniter 4 framework at MTs Ma'arif 30 Sumber Rejeki Mataram Lampung, several conclusions can be drawn. First, the development of the payroll system successfully addressed the main issues found in the existing manual system, particularly those related to inefficiency, human error in calculations, and the lack of transparency in salary distribution. By implementing this system, the administrative processes—especially payroll computation, attendance recording, payslip generation, and report creation—have become more automated, efficient, and accurate.

Second, the system's functionality was validated through Black Box and White Box Testing, and all major features, such as user login, data entry, QR code attendance scanning, salary calculation, and report generation, performed as expected. These results indicate that the system is functionally reliable and suitable for use in daily school operations.

Lastly, the proposed web-based system enhances transparency and user accessibility, particularly by enabling teachers to independently view their salary details and attendance history. This not only improves user satisfaction but also reduces the administrative burden. In conclusion, the payroll information system developed in this study provides a practical and scalable solution for managing payroll in educational institutions and can serve as a reference model for similar implementations in other schools.

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