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Developing LMS for Project-Based Learning to Enhance Web Programming Competence in Students

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Abstract. As one of the essential subjects in Software Engineering major, students in SMKN 2 Surabaya still face difficulty in learning the concept of Web Programming because of direct teaching using PowerPoint by the teacher. Ultimately, it caused difficulty in implementing the concept while developing the website. Project Based Learning (PJBL) is a learning approach that focuses on practical projects which is appropriate to the Web Programming Subject. Learning Management System (LMS) promotes autonomous study in various ways where student can learn according to their own pace and learning style which support Merdeka Curriculum. This study aimed to investigate the impact of the "BrainBoost" LMS on students' competencies in web server-side scripting programming based on PJBL. This research adopted an R&D (Research and Development) approach. The ADDIE model became the basis for designing and carrying out this research. To examine the impact, the pretest and post-test were administered. The average pretest and post-test score were 48.60 and 88. Paired sample t-test was used for data analysis. The study revealed that implementing LMS based on PJBL can effectively enhance student competency in the Web Programming subject class XII RPL 1 at SMKN 2 Surabaya.

Keywords: ADDIE; Learning Management System (LMS); Project-Based Learning; Student Competency; Web Programming

1. Introduction

Web programming is the process of creating and developing applications or websites using various programming languages, technologies, and tools used on the internet. This process includes writing code, designing, and developing features that can be accessed via the internet through a browser. Web programming is an essential subject in software engineering, a major in the vocational school. Based on a pre-survey by distributing questionnaires to 35 students in the XII RPL 1 class at SMKN 2 Surabaya, 82,8% of students agree that the teacher used direct teaching using PowerPoint and that not all the material in that ppt was taught by the teacher. These issues caused them quite difficulty in learning the concept, and in the end, it caused difficulty in implementing the concept while developing the website. The result of pre-survey can be found in Figure 1- Figure 4.

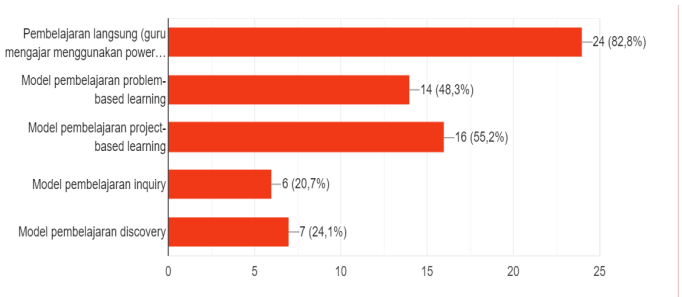


Figure 1 The data results on the teaching methods applied by the teacher in the web programming subject.

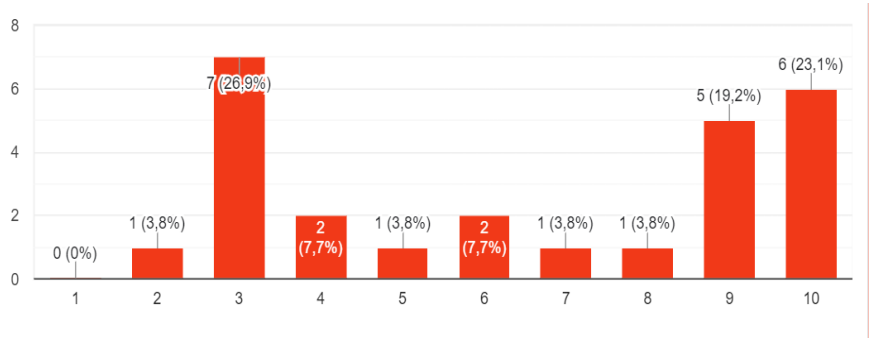


Figure 2 The data results indicate whether a teacher teaches the web programming material in that source.

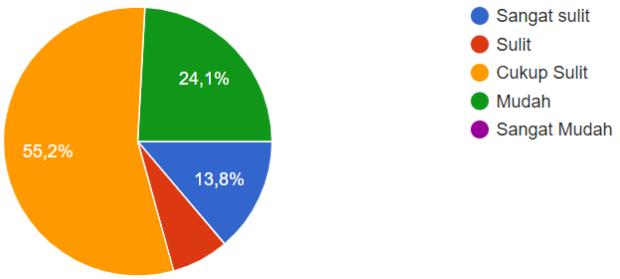


Figure 3 Results of student difficulty levels in web programming subjects.

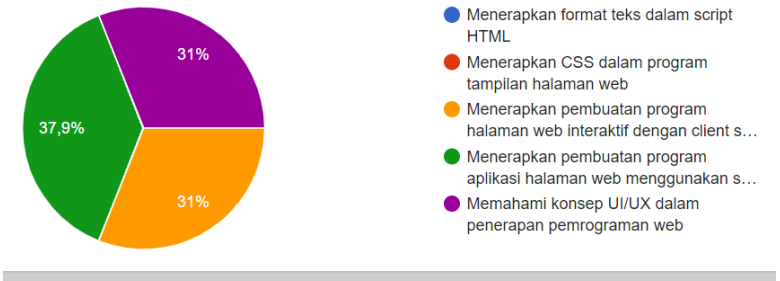


Figure 2 The data results on the most challenging material for students.

PJBL is a learning approach that focuses on practical projects. In line with active and collaborative learning methods, this approach allows students to build real projects, enabling them to understand web programming concepts more deeply (Ruslan et al. 2024). Conventional learning is often limited to teaching theory without significant practical experience. Students tend to be more engaged and understand better when applying those concepts to relevant projects (Karmila et al. 2022). Several studies have shown that the effectiveness of project-based learning (PJBL) has proven to deepen students' understanding and increase their engagement in the learning process in web programming subjects (Sudianto et al. 2019).

At SMKN 2 Surabaya, the Merdeka curriculum has been implemented. Merdeka curriculum is a new educational approach in Indonesia aimed at providing a more flexible and student-centered learning experience. It allows the student to learn at their own pace and in a way that best suits their learning style. One educational platform to support this new approach is the Learning Management System (LMS). LMS is a software platform to plan, implement, and assess learning programs. It is designed to streamline the delivery of educational content, track learner progress, and provide tools for both instructors and students. Learning Management System (LMS) also promotes autonomous study in various ways where student can learn according to their own pace and learning style through a website.

The development of web-based learning media with PJBL has the potential to contribute significantly to the education field, especially for the Merdeka curriculum. This study aims to develop an LMS that can support project-based learning and investigate its impact on student Web Programming competence.

2. Methods

This research uses the Research and Development method. The purpose of using this method is to create a specific product and test its effectiveness (Asmiyunda et al. 2023). ADDIE model will be used in the development of the LMS which consist of 5 stages as shown in Figure 5:

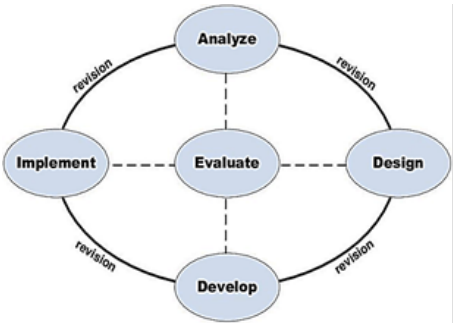


Figure 3 ADDIE Development Model

Below is the description for each stage:

a. The analyze stage helps in determining and explaining the needs of the system such as analysis of user functional and non-functional requirements.
b. The design stage helps determine the design to be applied. At this stage, preliminary designs, such as use case diagrams and wireframe designs, are made.
c. The development stage, aims to produce the product. LMS based on PJBL named "BrainBoost" will be developed using MOODLE platform version 4.4, vscode with the PHP (Hypertext Preprocessor) programming language version 8.1.25, and JS (Java Script). The database uses MySQL, and the online compiler is CodeMirror version 5. Before implementation, the LMS will be tested using blackbox testing and validated by subject matter and media experts.
d. The implementation is the product trial. The trial will be conducted in XII RPL 1 class SMKN 2 Surabaya for 35 students. There will be two sessions of the trial, which consist of a pretest, a teaching and learning process using BrainBoost, and a post-test.

e. The evaluation aims to assess the impact of the product on student competence. Descriptive statistical analysis will be used to summarize the validation result and pre and post-test scores. Before proceeding to the t-test, the normality of the data was assessed using the Shapiro-Wilk test. A significance value greater than 0.05 is considered acceptable, ensuring that the assumptions for conducting a parametric test are met. A paired sample t-test was conducted to compare the pretest and post-test scores to determine whether the intervention significantly impacts student competence.

Hypothesis

H_0 : The implementation of LMS based on PJBL (BrainBoost) does not enhance student competency in the Web Programming subject class XII RPL 1 at SMKN 2 Surabaya.

H_1 : The implementation of LMS based on PJBL (BrainBoost) enhance student competency in the Web Programming subject class XII RPL 1 at SMKN 2 Surabaya.

3. Results and Discussion

3.1. BrainBoost Development Stage

3.1.1. Analyze

The analysis stage focused on the initial data collection. The initial data were collected by interviewing a Web Programming teacher in class XII RPL 1 SMKN 2 Surabaya and distributing questionnaires to the XII RPL 1 students. The materials, hardware, software, and lesson plans were also analyzed during this stage.

3.1.2. Design

During this stage, the use case diagram and the basic layout were designed as a guideline to develop the LMS.

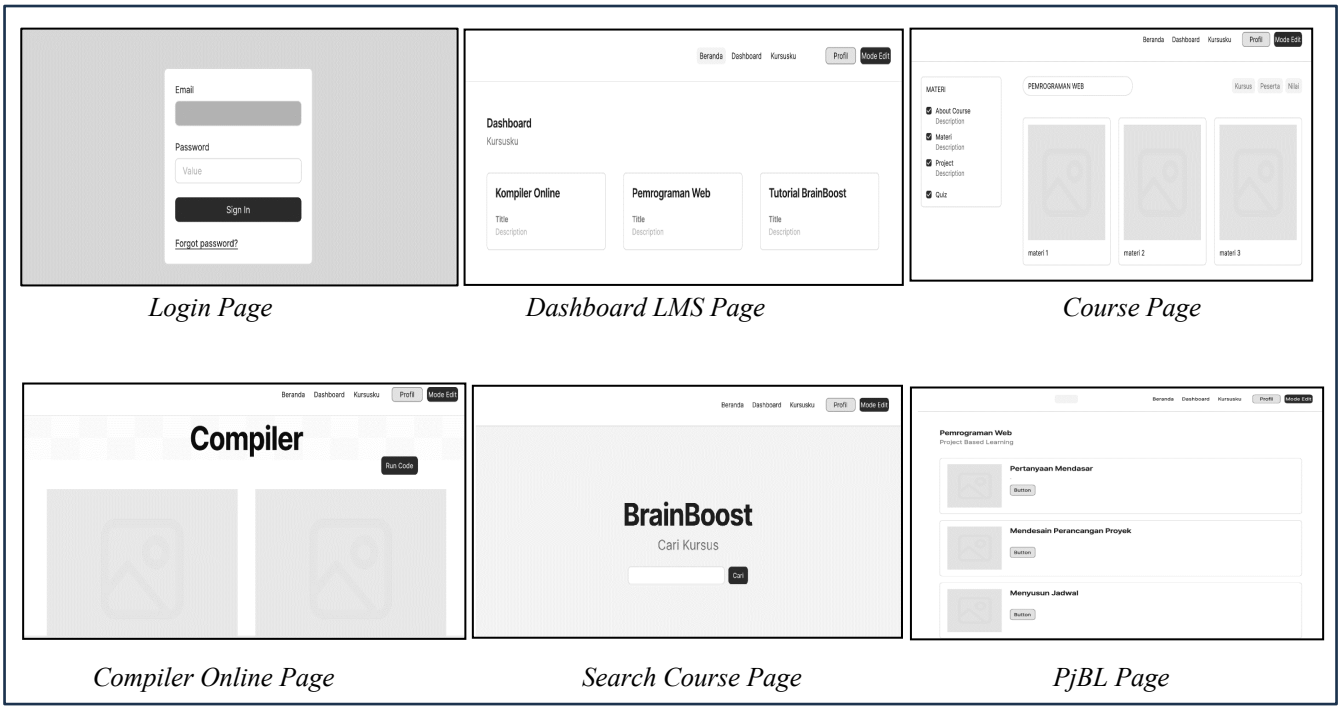
3.1.2.1. Use Case Diagram

Use Case Diagram is a visual representation of the reciprocal relationship between users and the system to complete tasks.

Figure 4 Use Case Diagram

3.1.2.2. Wireframe Design

Wireframes are used in the early stages of design to focus on the arrangement of elements, navigation, and functionality before proceeding to the more detailed visual design stage. Wireframes show the basic elements of the layout or structure of a web page or application without the details of graphic design or final content.



Login Page *Dashboard LMS Page* *Course Page*

Compiler Online Page *Search Course Page* *PjBL Page*

Figure 7 Wireframe for BrainBoost

3.1.3. Development

3.1.3.1. Login Page

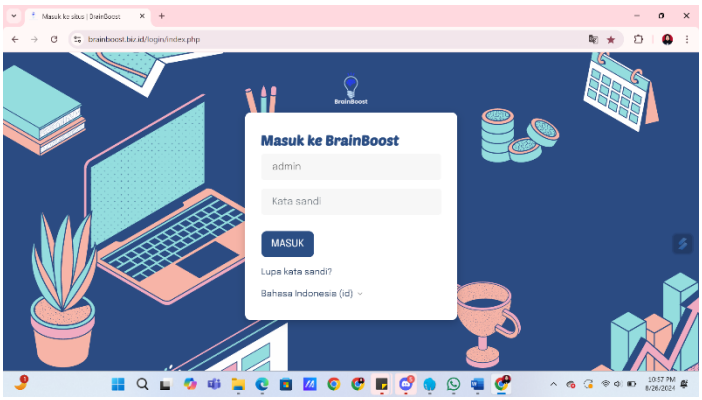


Figure 8 Login Page

The login page serves as user identity verification. To access the system, student or teacher have to enter valid login credentials. The visualization of the login page is displayed in Figure 8.

3.1.3.3. Course Page

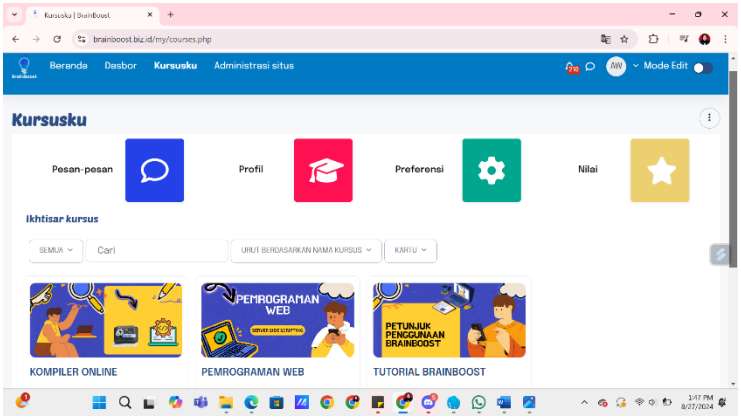


Figure 5 Course Page

This page serves as an information center containing a complete list of courses accessible to students and teachers. Users who have registered for the courses can access them on the website. Figure 9 visualizes the My Courses page.

3.1.3.4. Compiler Online Page

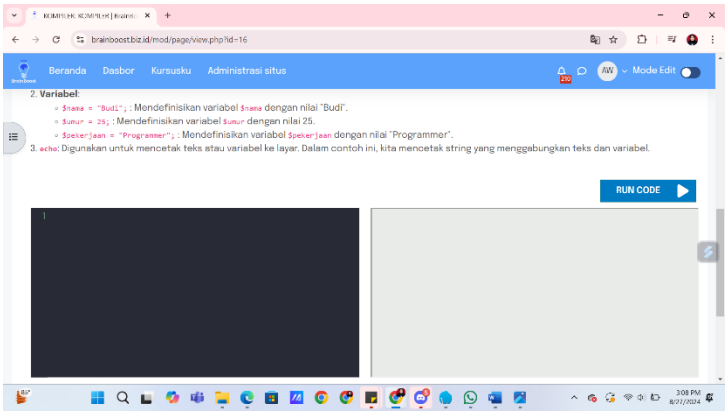


Figure 6 Compiler Online Page

This page presents an online compiler along with materials containing source code using the PHP programming language. On this page, students can try running code using the compiler provided in the course. The visualization of the Online Compiler page is displayed in Figure 10.

3.1.4. Implementation

The product that has been created and validated was implemented in an actual situation. The trial took place at SMKN 2 Surabaya in XII RPL 1 class. There were 35 students in the classroom. Two sessions of the trial consisted of a pretest, a teaching and learning process using LMS based on PjBL, and a post-test.The LMS was disseminated through the URL http://brainboost.biz.id/ .

3.1.5. Evaluate

Descriptive statistical analysis has been used to summarize the validation result and pretest and post-test scores. The normality of the data was assessed using the Shapiro-Wilk test, and the result showed that the assumptions for conducting parametric tests were met. Finally, the paired sample t-test was conducted to compare the pretest and post-test scores to determine whether the intervention has a significant impact on the student's competence.

3.2. Results

To check the validity of instruments, including lesson plans, materials, test questions, and media (BrainBoost LMS), some experts, consisting of lecturers and teachers, were asked to validate them by filling out the rubric prepared by the researcher. The validation results from the experts are shown in Table 4.

Table 1 Recapitulation of Validation Results

No.	Validation Assessment	Validity	Explanation
1	Media	91.20%	Very Valid
2	Materials	96%	Very Valid
3	Test Question	95.45%	Very Valid
4	Lesson Plan	86.66%	Very Valid

The descriptive statistical analysis demonstrated an enhancement in students' Web Programming competence following the implementation of BrainBoost LMS. The improvement was reflected in the mean score before and after the implementation of BrainBoost. The post-test average of 88 is higher than the pretest average of 48.6. To test the normality of the data, Shapiro Wilk test is administered and the p value for both pretest and post-test were 0.062 and 0.057 respectively. Both values are greater than 0.05, indicating that the data were normally distributed.

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Kelas	Statistic	df	Sig.	Statistic	df	Sig.
Hasil Belajar Siswa	Pretest Kognitif	.136	35	.100	.941	35	.062
	Posttest Kognitif	.168	35	.014	.940	35	.057

a. Lilliefors Significance Correction

Figure 11 Data Normality

Finally, to define the significance enhancement of student Web Programming competence using BrainBoost, a paired sample t-test was used to analyze the data, as shown in Figure 12. The result of paired sample t-test showed a significant difference in pretest and post-test scores (p-value < 0.01), indicating that the implementation of LMS based on PJBL (BrainBoost) enhances student competency in the Web Programming subject class XII RPL 1 at SMKN 2 Surabaya.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	PRE TEST - POST TEST	-39.429	16.968	2.868	-45.257	-33.600	-13.748	34	<.001

Figure 12 Results of Paired Sample t-test

4. Conclusions

The results of expert validation for each instrument, such as media, materials, test questions, and lesson plans, have met the validity criteria with percentages of 91.2%, 96%, 95.45%, and 86.66%, respectively. The validity analysis indicates that this learning media has met all the criteria needed to achieve the learning objectives, with an average score of 92.32%. Therefore, this media can be used to support the learning process. The paired sample t-test shows a significant value of <.001, so that the null hypothesis (H0) is rejected. Implementing the BrainBoost has positively impacted the achievement of learning objectives, significantly improving students' test results in the subject Web Server Side Scripting Programming.

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