

## Code Simulator Website for Project-Based Learning to Improve Front End Development Competence

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**Abstract.** This research develops a web-based code simulator application that uses HTML, CSS, and JavaScript to support web programming learning. This application aims to improve students' competence in creating websites through a project-based learning model. The research uses the ADDIE method and the prototype development model, targeting XI RPL students at SMK PGRI 2 Sidoarjo. The instruments used include material validation sheets, pretest-posttest questions, lesson plans, and media. The research results show a significant improvement in students' learning outcomes after using the code simulator application, with material validation scores of 92.5%, lesson plans (RPP) 89%, and media 95.2%. The use of this application also reduces students' dependence on personal hardware. Based on research conducted before the development of this application, several issues were identified during the implementation of PLP activities, including students facing difficulties in accessing adequate hardware for front-end website development learning, a lack of effective learning media to enhance students' understanding of HTML, CSS, and JavaScript programming languages, and the need for project-based learning to be supported by an application that can assist students in independently organizing and evaluating programming language materials. With the presence of a web-based code simulator application, some of these issues can be proven by the increase in students' competencies in web programming learning using the quantitative pretest-posttest method.

**Keywords:** Code Simulator; Project-Based Learning; Web Programming; Website; Front-End Development Competence

### 1. Introduction

Education is one of the main capital that must be obtained by a person in the process of learning. Good training will produce qualified human beings and students who can compete in the world of work. Develop this qualified and competent personnel, Facilities will be designed specifically for the student learning process under the supervision of teachers. This institution is called a school. Monotonous (always the same) material teaching becomes one factor that requires a change in the learning process. In addition, the development of science and technology has also made it easier for teachers to create media learning (Muyaroah & Fajartia, 2017).

This information technology also emerged as a resource with valuable values to support the teaching and learning process so that students can acquire new knowledge effectively through information technology (Vásquez-Ramírez et al., 2016). Role Technology is developing rapidly in the world of Education. The current need for technology is indispensable in the era of globalization. All aspects of life have used the internet to support the smooth acquisition of fast-paced information. The progress of an educational institution can be seen in how the school utilizes Information Technology and

Communication (ICT) according to needs and optimal. Utilization of technology needed in The school has the goal of helping learning activities teach (Mustari, M. (2023).

Currently, e-learning has been widely accepted by the world of education, as evidenced by the many implementations of e-learning in educational institutions such as schools that have implemented e-learning to support the learning process teaching in schools, but the application of e-learning has not been utilized optimally. Based on a survey carried out by (Suhartanto, 2009) the total number of schools that have a learning site from 187 schools spread across 20 provinces, with dominance on the island of Java. The five top provinces are Central Java, West Java, DI Yogyakarta, East Java, and DKI. The data shows that the quality of school e-learning sites in Indonesia is below minimum. The quality of the content of the e-learning sites of these schools is not well maintained; some sites have errors and do not connect to a site containing learning materials. Most of the sites that experience errors are self-hosted somewhere. What's comparatively better is the site of some schools that work the same as an institution that has patents in site management e-learning (Seputro, Y. 2006).

Digital transformation is the beginning of the creation of a new way to more effectively and efficiently utilize existing technology. Technology has changed education, providing access to broader learning resources and supporting flexibility in teaching methods. This is in line with the global trend where education is increasingly Integrated with technology to improve quality learning in terms of psychomotor competency level students learning the basics of web programming and preparing the younger generation to face the demands of the times front. Improvement of students' basic programming competencies in using technology and the ability to Learning independently has become a priority. Most important in the Software Engineering (RPL) study program at Vocational High School level, such as SMK PGRI 2 Sidoarjo, where students are required to have in-depth understanding of information technology. Wrong One technology that will be built is media Techcode learning. Techcode is a platform Learning that implements structured learning website-based. In the web-based Techcode application, Students can do the reading of the written program in the source language which is then translated into other languages so that it can give rise to output.

The translator application is called a code simulator, or what we often hear of as a compiler. In this Techcode application, students can conduct experiments in running application programs using a specific programming language. It is hoped that students can more easily understand programming learning materials and increase interest and competence in student learning outcomes. To achieve the objectives of the research problem, the researcher will conduct a study with a problem formulation to test the validity of the media and then apply it to students so that they can know the effectiveness of the use of media measured by conducting a pre-test and post-test. The pre-test and post-test results will be analyzed using the SPSS application. Based on the problem to be solved, the researcher will provide proof that the use of website-based learning media through research entitled "Design and Build a Website Code Simulator in Project-Based Learning to Improve the Competence of Front End Development Learning Outcomes at SMK PGR 2 Sidoarjo" can improve students' interest in learning and be able to motivate students in participating in learning at school.

## **2. Methods**

The type of research that this study uses quantitative research methods. Quantitative research methods are research methods that utilize sampling and random population, then the data that has been collected Data analysis will be carried out using statistics to conducting tests of existing hypotheses (Sugiyono, 2016:13).

The development model used in this study using the ADDIE development model consisting of five stages, namely Analyze, Design, Development, Implementation, and Evaluation. This development model aims to produce a web-based Techcode code simulator application with project-based models and test the level of understanding competencies of students' web programming learning outcomes in learning. As can be seen from Figure 1, there are five models development that will cooperate and be regulated in a way that and a specific order.



**Figure 1 - ADDIE Development Model**

In Figure 1 this is development model aims to generate Techcode-based code simulator applications website with project-based model and test the Understanding the Competencies of Web Programming Learning Outcomes students in the learning.

**$O_1 \times O_2$**  (1)

(sugiyono, 2011:111)

**Where  $O_1$  is pretest results before using media,  $O_2$  is Posttest results after using media.** The ADDIE model is a framework used in instructional development and learning design. ADDIE is an acronym for the five main steps consisting of Analysis, Design, Development, Implementation, Evaluation. each of these stages has its own specific tasks, the ADDIE model is iterative, meaning it can be repeated and adjusted based on evaluation results to improve the quality of learning.

### *2.1 Population And Sample*

The population in this study is all Class XI students at SMK PGRI 2 Sidoarjo majoring in software and game development (PPLG), with a total of 28 students.

### *2.2 Validation Assessment Analysis*

The validity of the learning media is declared valid based on the suitability of the validation results between the validator and the predetermined validity criteria. The criteria for scoring the answers to the validation sheet are shown in table 2 illustration:

**Table 1** - validation assessment categories

Score	Criteria
5	Very good (VG)
4	Good (G)
3	Good Enough (GE)
2	Not Good (NG)
1	Very Bad (VB)

Based on the results of the validation evaluation that have been analyzed, the formula for calculating the percentage of validity from filling out the validation sheet is presented:

$$\text{Validity Score} = \frac{\text{Total score obtained}}{\text{Total maximum score}} \times 100\%$$

**Table 2** - Validation percentage category

Score	Criteria
$82\% < x \leq 100\%$	Very Valid
$63\% < x \leq 81\%$	Valid
$44\% < x \leq 62\%$	Less Valid
$25\% < x \leq 43\%$	Not Valid

### 2.3 Analysis of Competency Improvement of Learning Outcomes Web Programming on Students

The learning analysis technique used in this study is a difference analysis using the T-Test formula that involves two samples and uses a program SPSS application. Before conducting the T-Test, it is necessary to take the steps are as follows:

#### 2.3.1 Normality Test

Normality testing is done to check the normality of the distribution of each variable. This test was conducted using the Kolmogorov-Smirnov and Shapiro-Wilk methods.

#### 2.3.2 Homogeneity Test

Homogeneity tests are used to show that two or more groups of sample data are from populations that have the same variation. Test homogeneity is applied to the post-test result data from experimental group and control group.

#### 2.3.3 Hypothesis Test

Description of the final stage analysis is done after all The necessary data is collected. After the test result data analyzed by conducting an analysis prerequisite test followed by hypothesis testing. Hypothesis tests are used to find out whether the research hypothesis process has been formulated to be accepted or otherwise. Test T used are two samples, this test is classified as a test comparisons (comparative tests) that have the purpose of Comparing between the two data (variables) has differences or similarities. Hypothesis testing and The results will be used as a reference in withdrawals conclusions with the following criteria:

- If the significance  $(P) < 0.05$  then  $H_0$  is rejected and  $H_1$  is Accepted.
- If the significance  $(P) > 0.05$  then  $H_0$  is accepted and  $H_1$  is Rejected

## 3. Results and Discussion

### 3.1 Development Result of E-Learning Website "Techcode"

E-Learning website is designed using ADDIE development model with project-based learning style which aims to develop computational thinking skills.

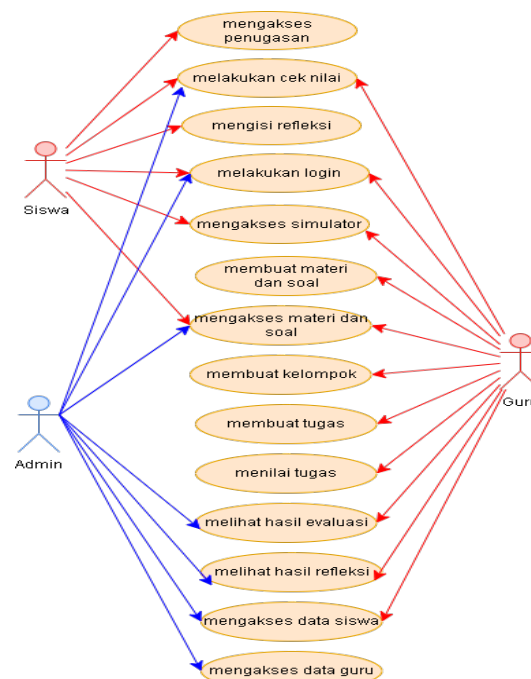
### 3.1.1 Analysis

Media development is carried out with the aim of meet the learning needs at SMK PGRI 2 Sidoarjo in the subject of Web Programming in the field of expertise Software Engineering. At the analysis stage, it is carried out Field study activities conducted by interviews directly to the subject teacher Web Programming, namely Mrs. Nurhidayati Zulikurniati, S. Kom. In the curriculum analysis, it was found that the curriculum that used at SMK PGRI 2 Sidoarjo using the curriculum Freedom of Learning. Analysis of subjects and teaching modules that used to assist in creating media learning to match the desired learning objectives Reached. In the field study conducted by the researcher directly see the conditions of the computer laboratory, do learning, and making observations during the implementation of PLP (Introduction to School Field).

### 3.1.2 Design

The second stage is the design or design stage. At the planning stage of making an application is carried out Application diagram design, material preparation, preparation questions, prepare a Learning Implementation Plan (RPP) and Preparation of Assessment Instruments and Data Collection other supporters.

#### 3.1.2.1 Use Case Diagram



**Figure 2** - Use case diagram (admin, teacher, student)

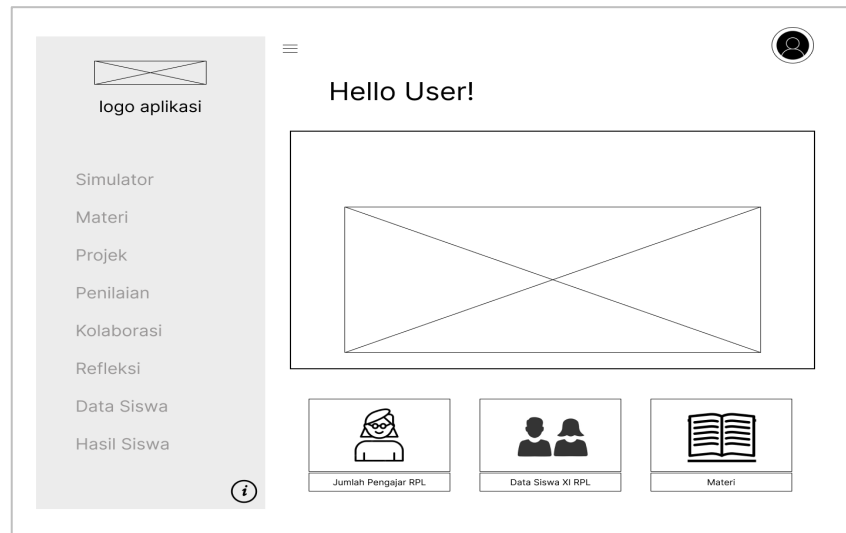
Here is a use case diagram Below is the flow of designing a code application system Techcode simulator that every user has the right to access different.

The Figure 2 describes the interaction between actors, such as students, teachers, and administrators, with various key features provided by the application. Use case diagram It provides a visual description of how Various entities will interact with the system. Use case The diagram will be a

guide in the design process Techcode simulator code application system in order to meet user needs and can achieve the goal good learning.

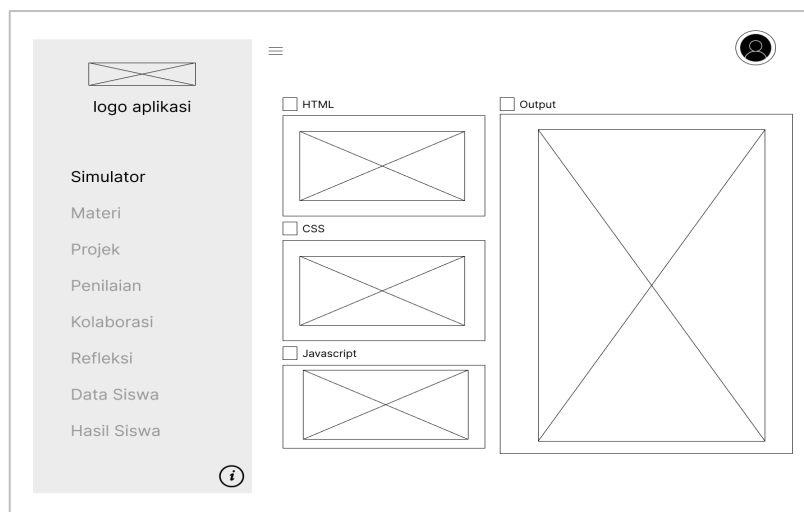
### 3.1.2.2 Initial design of “Techcode” E-Learning Website

Here is the wireframe design of the Techcode website that is used by admins, teachers, and students after log in.



**Figure 3** - Dashboard page on all users

In Figure 3, the main page is displayed. On this page, the access rights are held by the admin. Admin can perform CRUD on announcements so that the announcements created can appear on the main page for students and teachers.



**Figure 4** - Code Simulator website page on users

In Figure 4 of the code simulator page, application users consisting of students and teachers can access this page. On the code simulator page, users can experiment with programming by entering a series of codes using web programming languages consisting of HTML, CSS, and JavaScript. When the

lines of code are entered, the automatically generated output will appear in the output column. With that, users do not need to run it manually or even leave the web tab to see the output after writing the program.

### 3.1.3 Development

The development stage, the production process is carried out in developing products in the form of learning media from the initial form of design to the actual product that is adjusted to the previous plan that has been made. At the development stage, products are produced in the form of learning media. The following are the results of the development of learning media.

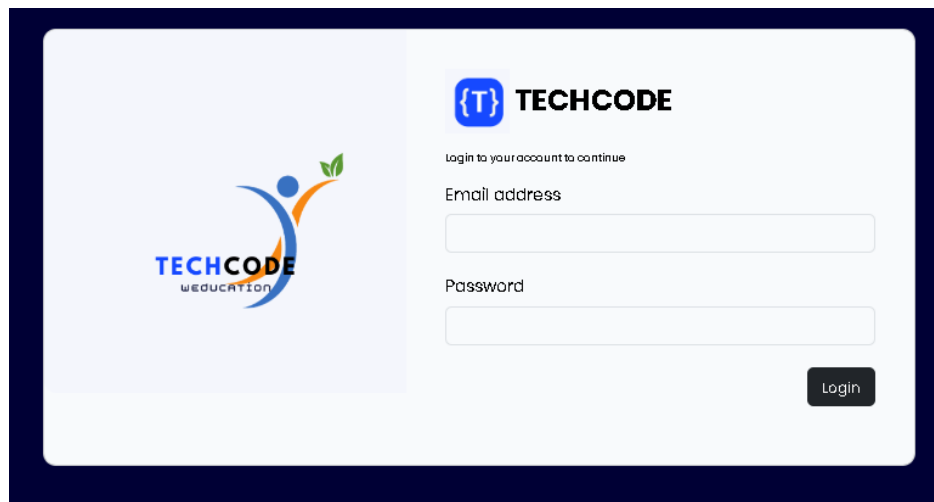


Figure 5 - Initial view when the user login

In Figure 5, there is the login page for the Techcode web-based learning media. On the login page, users can enter the email and password provided by the admin to access the features of the application.

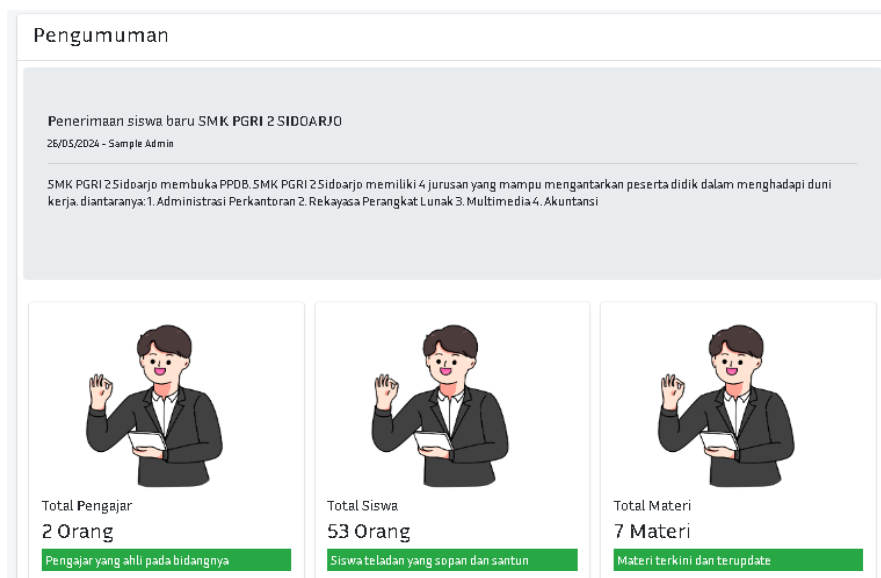
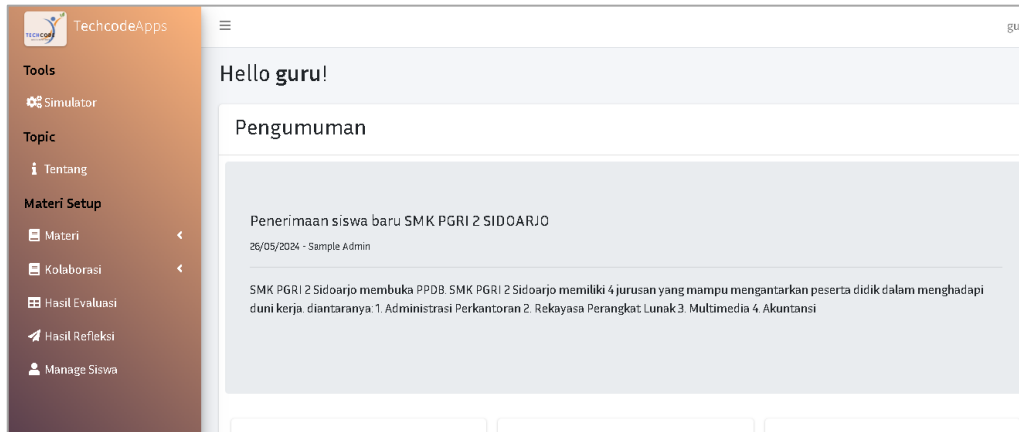


Figure 6 - Dashboard page view after the user successfully login

Figure 6, the main page of the Techcode website code simulator application is shown. After the user (admin, teacher, student) logs in, the main page or application dashboard will appear. On this page, the website will display several pieces of information uploaded by the admin, such as announcements, the number of educators, and the number of students in the RPL or PPLG classes. Each user will be presented with different application features.



**Figure 7** - Features provided to teacher users

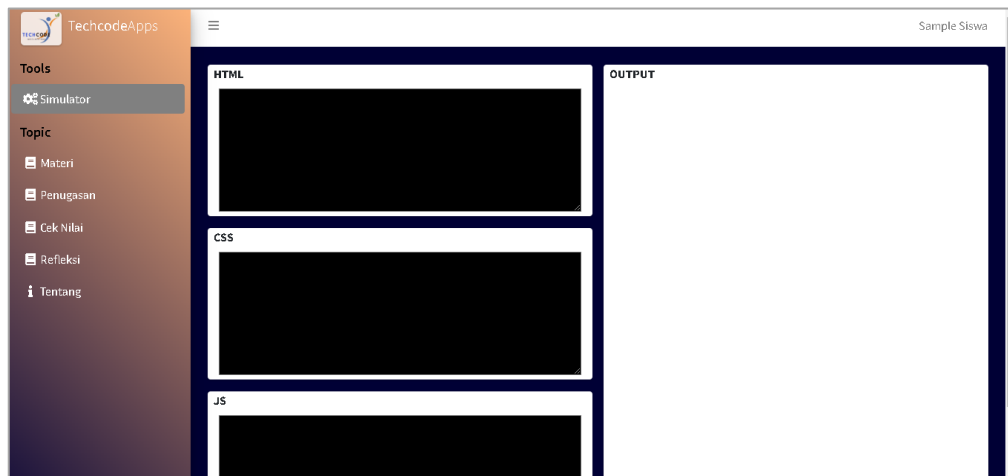
In Figure 7, the teacher's dashboard page is displayed. On this page, teachers have access rights to features that will manage learning activities with students in a learning process. On this website, teachers have access to the material feature (material creation), collaboration (group creation, assignment giving, and assignment assessment), evaluation results of learning activities, reflection results, and student management to ensure all students are recorded in the class data.



**Figure 8** - Features provided to student users

In Figure 8, the student dashboard page is displayed. On this page, students have access rights to features that will follow the learning activities created by the teacher in a learning process. On this website, students have access to features such as materials, assignments, checking assignment grades, and filling out reflections on the learning process.





**Figure 9** - Simulator Features

In Figure 9 is the simulator page. On this page, students and teachers can code using HTML, CSS, and JavaScript programming languages, complete with their output results.

#### 3.1.4 Implementation

After designing the application, the next step is to carry out the implementation stage. At the implementation stage. The researcher carried out several validation activities for validator experts, namely media validation, material validation, question validation, and RPP validation. The purpose of validation activities is to test the validity and feasibility of the products that have been developed.

#### 3.1.5 Evaluation

The last stage in the development method used is the evaluation stage. This stage is carried out with the aim of validating media products that have been developed through expert tests after conducting expert tests, then processing the resulting data is carried out. The following are the results of the validation test.

### *3.2 Discussion of Validation Results*

The results of the validation activities can be seen as follows:

**Table 3** - Discussion of validation results

<b>Validation Assessment</b>	<b>Validity</b>	<b>Description</b>
<b>RPP</b>	89%	Very Valid
<b>Media</b>	95,2 %	Very Valid
<b>Materi</b>	92,5%	Very Valid
<b>Soal</b>	90%	Very Valid

### *3.3 Cognitive Test Results*

The results of student grades are used to measure the results of student competence. At this stage, the researcher compared the scores obtained by students before and after using the Techcode simulator

website by using several tests as proof. The following are the results of the student learning outcome data test:

### 3.3.1 Normality Teast (Cognitive)

The results of the normality test using the Kolmogorov-Smirnov method from the Shapiro-Wilk test stated that the significance value in the pretest was 0.277 with  $\alpha = 5\%$  or 0.05 and the significance value in the posttest was 0.061 with  $\alpha = 5\%$  or 0.05. Thus, it can be concluded that the data is normally distributed with a significance value of  $> 0.05$ . As explained in the Figure 10.

Tests of Normality						
	Kolmogorov-Smirnov <sup>a</sup>			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
PRETEST1	.122	25	.200 <sup>*</sup>	.952	25	.277
POSTEST1	.113	25	.200 <sup>*</sup>	.923	25	.061

\*. This is a lower bound of the true significance.  
a. Lilliefors Significance Correction

Figure 10 - Normality test (cognitive)

### 3.3.2 Homogeneity Test (Cognitive)

The results of the calculation of the pre-test and post-test score data using the Homogeneity Test with a significance value of 0.813 with  $\alpha = 5\%$  or 0.05 so that it can be concluded that the data is homogeneous. As explained in the Figure 11.

Tests of Homogeneity of Variances					
		Levene Statistic	df1	df2	Sig.
Pretest dan Posttest Kognitif	Based on Mean	.056	1	54	.813
	Based on Median	.147	1	54	.703
	Based on Median and with adjusted df	.147	1	43.363	.703
	Based on trimmed mean	.066	1	54	.798

Figure 11 - Homogeneity Test (Cognitive)

### 3.3.3 Hypothesis Test (Cognitive)

Based on the results of the calculation in Figure 12, it can be concluded that the pretest and posttest data are very significant because they have a significance value ( $P$ )  $< 0.005$ , which is  $< 0.001$ , then  $H_0$  is rejected and then  $H_1$  is accepted. So, from the results of the calculation, it can be stated that the web-based Techcode simulator code learning media with the PJBL learning model can improve the competence of the learning outcomes of grade 11 students in the field of RPL expertise. As explained in the Figure 12.

Paired Samples Test									
		Paired Differences							
		95% Confidence Interval of the Difference					Significance		
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	One-Sided p
Pair 1	Pretest - Posttest	-28.464	12.642	2.389	-33.366	-23.562	-11.914	27	<.001
									Two-Sided p
									<.001

**Figure 12 - Hypothesis Test (Cognitive)**

### 3.4 Psychomotor Test Results

In the results of student grades used to measure the results of student learning competencies, data were obtained before and after students used Techcode learning media to learn practice in a psychomotor context.

#### 3.4.1 Normality Test (Psychomotor)

The results of the normality test using the Kolmogorov-Smirnov method from the Shapiro-Wilk test stated that the significance value in the preproject work was 0.086 with  $\alpha = 5\%$  or 0.05 and the significance value in the postproject was 0.263 with  $\alpha = 5\%$  or 0.05. Thus, it can be concluded that the data is normally distributed with a significance value of  $> 0.05$ . Shown in the Figure 13

Tests of Normality						
Kolmogorov-Smirnov <sup>a</sup>				Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
PreProject	.127	33	.194*	.934	33	.086
PostProject	.124	33	.200*	.960	33	.263

\*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

**Figure 13 - Normality Test (Psychomotor)**

#### 3.4.2 Homogeneity Test (Psychomotor)

The results of the calculation of pre-project and post-project value data using the Homogeneity Test with a significance value of 0.416 with  $\alpha = 5\%$  or 0.05 so that it can be concluded that the data is homogeneous. Shown in the Figure 14

Tests of Homogeneity of Variances					
		Levene Statistic	df1	df2	Sig.
projek1	Based on Mean	.672	1	54	.416
	Based on Median	.237	1	54	.628
	Based on Median and with adjusted df	.237	1	50.534	.628
	Based on trimmed mean	.457	1	54	.502

**Figure 14 - Homogeneity Test (Psychomotor)**

### 3.4.1 Hypothesis Test (Psychomotor)

The results of the calculation of the Hypothesis Test using the T Test. Based on the calculation results in Figure 15, it can be concluded that the preproject and postproject data is very significant because it has a significance value ( $P$ )  $< 0.005$ , which is  $< 0.001$ , then  $H_0$  is rejected and then  $H_1$  is accepted. So, from the results of the calculation, it can be stated that the web-based Techcode simulator code learning media with the PJBL learning model can improve the competence of the learning outcomes of grade 11 students in the field of RPL expertise. Shown in the Figure 15

Paired Samples Test									
		Paired Differences				Significance			
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	
					Lower	Upper			One-Sided p Two-Sided p
Pair 1	Preprojek - Postprojek	-12.536	4.918	.929	-14.443	-10.629	-13.489	27	<.001 <.001

Figure 15 - Hypothesis Test (Psychomotor)

## 4. Conclusions

The web-based Techcode simulator code learning media was developed to be used as a research using the ADDIE development method. In this study, entitled "Design and Build a Code Simulator Website on Project-Based Learning to Improve the Competence of Front End Development Learning Outcomes (Case Study of SMK PGRI 2 Sidoarjo)" is classified in four aspects to test the feasibility, namely conducting a validity test of materials, questions, lesson plans, and media. For the validity of the material, the final score was 92.5. The validity of the RPP obtained a final score of 89. The validity of the question obtained a final score of 90. The media validity obtained a final score of 95.2. And has gone through the Blackbox test process with the results of all application feature tests according to user expectations. All validities are included in the high validity category so that they are suitable for use and can be implemented in web programming subjects on HTML, CSS, and Javascript materials in grade XI majoring in RPL at SMK PGRI 2 Sidoarjo. The design of this website has been successfully developed and obtained a very good validity category and it can be interpreted that this module is suitable for use in the teaching and learning process in web programming subjects in class XI RPL SMK PGRI Sidoarjo. The next researcher, it is hoped that they can continue their research by always developing and adding features so that the Techcode simulator code defense media becomes better.

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