Journal of Education Technology and Information System Vol (01) Ed (02) P.98-108 (2025)
Received November 2024 / Revised February 2025 / Accepted June 2025

Journal of Education Technology and Information System

https://journal.unesa.ac.id/index.php/jetis/

Develop Sinawang Plugin with PjBL in Moodle to Improve Network Administration Competence

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Abstract. This study addresses the limited integration of Project-Based Learning (PjBL) methodologies in vocational education, particularly in enhancing Network System Administration competence for class XI TKJ students at SMKN 1 Kediri. Despite the proven effectiveness of PjBL, its integration with digital platforms like Moodle remains underexplored, especially in technical subjects. To bridge this gap, the 'Sinawang' plugin was developed on Moodle to support PjBL methodologies. Using a Research and Development (R&D) approach, the plugin was designed and tested through black-box validation and developmental testing. Results indicated high validity levels for the media (88%), lesson plans (83%), materials (80%), and assessments (83%). Comparative analysis of pretest-posttest scores revealed significant improvements: cognitive test averages increased from 52.8 (pretest) to 86.6 (posttest), while psychomotor scores rose from 74.5 to 85.9. Paired sample t-tests confirmed statistically significant differences (Sig. 0.000 < 0.05), affirming the plugin's effectiveness. The findings demonstrate that the Moodle-based 'Sinawang' plugin, integrated with PjBL, effectively enhances both cognitive and psychomotor competencies in network system administration. This study concludes that technology driven PjBL tools can optimize vocational learning outcomes, providing a scalable model for similar educational contexts and contributing to the advancement of digital learning in vocational education.

Keywords: Learning plan; Moodle; Network System Administration; Plugin; Project-based learning.

1. Introduction

In this digital era, with rapid advancements in information technology, the need for updates in teaching methods is increasingly critical (Novita Pujianingtias and Januar Saputra, 2019). The broad application of information technology across sectors significantly influences educational innovations (Effendi and Wahidy, 2019). Skills within Computer and Network Engineering Program, or in Indonesia it called TKJ, are essential to meet the constant demands of the technological world (Sardi and Habibullah, 2022). Given the complexities of network system administration and ongoing industry changes, efforts to improve education quality in this area are needed.

The TKJ program plays a strategic role in advancing information and communication technology skills. Defined as involving competencies in algorithms, programming, computer assembly, networking, software operation, and the internet (Novita Pujianingtias and Januar Saputra, 2019), network system administration is particularly crucial, providing a foundation for TKJ students to become network administrators. Learning network administration requires both technical understanding and conceptual mastery to achieve high standards (Antonius, 2013).

Project-Based Learning (PjBL) has been increasingly adopted in vocational education to bridge the gap between theoretical knowledge and practical skills (Chen and Yang, 2019). Recent applications, such as those by (Almarzooq et al., 2020), highlight its adaptability to virtual learning environments like Moodle. (Sutirman, 2013) and (Fazri, 2022) emphasize that this model extends

beyond skill acquisition, promoting real projects that actively involve students. The Moodle platform, with its customizable plugin architecture, has been widely used to support PjBL in technical education (Nadiyah and Faaizah, 2015). Choosing the right model, like PjBL, significantly impacts student engagement and outcomes (Bakhrun Najkhi, 2022). PjBL employs projects as learning media, engaging students in stages from basic questions to assessments, creating a holistic, real-world learning context (Nurhidayah et al., 2021). Implementing PjBL in education is expected to significantly improve student understanding and outcomes.

This research aims to improve TKJ students' learning competence and experience by developing the Moodle-based "Sinawang" plugin. The 'Sinawang' plugin was developed using a structured 4D model, informed by (Maćias, 2012), who emphasized the importance of iterative design in educational tools. Originally called Learning Plans, this plugin manages lesson plans, now enhanced with interactive features like ratings, completion tracking, competency statistics, feedback, and improved visuals. These developments aim to streamline lesson plan management, strengthen competencies, especially in network administration, and boost student skills.

This study examines PjBL's positive impact on learning and the implementation of "Sinawang" by analyzing the competence improvements of TKJ students in network administration, this research aims to contribute to better quality in network administration education, integrating learning technology, and supporting TKJ students through PjBL.

In conclusion, rapid technological progress requires updates in teaching methods, particularly in TKJ. PjBL has proven effective in enhancing practical skills and conceptual understanding. The Moodle-based "Sinawang" plugin implementation is expected to elevate TKJ students' competence and experience, especially in network system administration.

2. Methods

2.1. Research Flow

The research process was carried out systematically through several stages. The first stage was Problem Identification, in which the issues and gaps within the existing learning process were examined to determine areas requiring improvement. This was followed by a Literature Review to explore relevant theories and previous studies that could serve as the foundation for addressing the identified problem. The next stage, Plugin Design, involved preparing a comprehensive design plan that outlined the features, interface, and functionality of the plugin. Once the design was finalized, the Plugin Development stage was conducted by constructing the plugin according to the specifications using suitable programming languages and development tools. After development, the Validation and Testing stage was implemented to ensure that the plugin met the established standards and operated as intended. The subsequent stage, Data Analysis, focused on examining the data obtained from validation and implementation activities to evaluate the plugin's effectiveness in enhancing student learning outcomes. Finally, the process concluded with Conclusion and Recommendations, in which the findings were synthesized, conclusions were drawn, and recommendations for future improvements or broader implementations were provided. Flowchart of the research process shown in Figure 1.

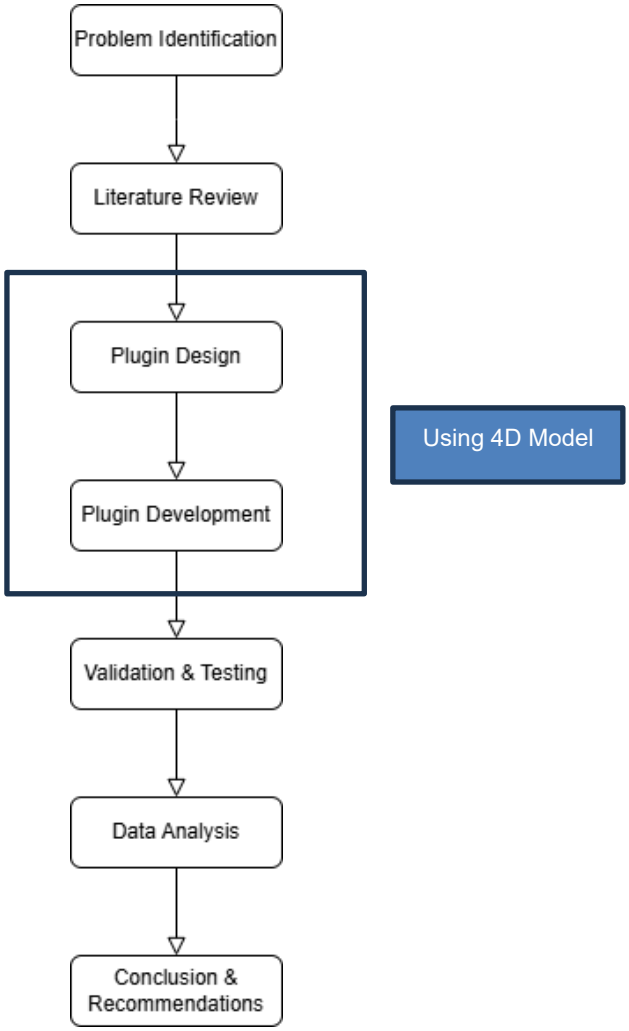

Figure 1 Flowchart of the research process

2.2. 4D Model

The "Sinawang" research utilized the Research and Development (R&D) method, specifically the 4D development model introduced by (Thiagarajan et al., 1974). According to (Sugiyono, 2013), R&D is a method aimed at producing a specific product and testing its effectiveness. The 4D model consists of four main phases: Define, Design, Develop, and Disseminate, each intended to ensure that the product meets user needs and is effective in its application. This model is used in the design and development stage. The stages of the 4D model can be seen in Figure 2.

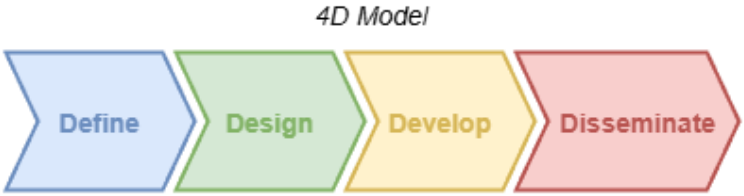

Figure 2 4D development model

In the Define stage, curriculum-based content needs and technical requirements were identified to formulate clear learning objectives and targeted competencies. The Design stage focused on planning the plugin's interface, functionality, and key features to ensure effective student engagement

and alignment with pedagogical goals. During the Develop stage, the plugin and accompanying instructional materials were constructed according to the design specifications, resulting in a fully functional Moodle-based learning tool. Finally, in the Disseminate stage, the plugin was implemented within the learning environment, validated through testing, and refined based on user feedback to maximize its effectiveness and instructional impact.

2.3. Validation and testing

This research checks the validity of the content in "Sinawang" plugin, such as the lesson plans (RPP), media, learning materials and the quiz, by choosing lecturer from Informatics Engineering Department and teachers from SMK Negeri 1 Kediri as validators. The validators check it, give the point of its component, and make sure it fit to the rule.

After application development and content validation is done, then we implement the application to the the population. This experiment was conducted to determine whether this application could have an impact on the population and to prove the hypothesis. This research used a population of students majoring in Computer and Network Engineering at SMK Negeri 1 Kediri, with a sample of 40 students from class XI TKJ. The product trial design included both Pre-test and Post-test evaluations.

Table 1 Product test scheme

O_1	**X**	**O_2**

Table 1 shows the product test scheme, where O_1 is pre-test results of the experimental class (before treatment), X is treatment or intervention (use of the plugin or learning media) and O_2 is post-test results of the experimental class (after treatment)

The data collection process was conducted for 1 month after the plugin "Sinawang" development was completed. Testing was carried out using both pre-test and post-test methods. The pre-test measured cognitive aspects through a multiple-choice test consisting of 25 questions. After the learning process, the post-test assessed psychomotor aspects through practical problem-solving based on case studies. Direct observation of the research object was conducted to gather additional information after the research activities. Additionally, documentation was used as a process of collecting and storing information to support the research process. Documentation data could include photos of activities during the research.

The validity of the learning media is determined using a Likert scale, which measures the suitability of the validation results between the validators and the predetermined validity criteria. The answer scores reflect the criteria that shown in Table 2.

Table 2 Validation score criteria

Score	Criteria
4	Good
3	Good enough
2	Not good
1	Very Bad

Based on the results of the validation evaluation that have been analysed, the formula for calculating the percentage of validity from filling out the validation sheet is presented in equation 1.

$$Validity\ Score = \frac{Total\ Score\ Obtained}{Total\ Maximum\ Score}\ x\ 100\% \qquad (1)$$

After calculating the value of validity score using Formula 1, it is then categorized according to Table 3. If the result falls within the range of $81\% < x \leq 100\%$, the product is classified as Very Valid, meaning it is highly feasible to use with no or only minor revisions. When the score is within 61% <

$x \leq 80\%$, it is categorized as Valid, indicating that the product is appropriate but may require slight improvements. If the result is in the range of $41\% < x \leq 60\%$, it is considered Enough Valid, suggesting that the product can still be used but requires substantial revisions. Furthermore, when the value lies between $21\% < x \leq 40\%$, the product is classified as Not Valid, implying that it is not suitable for use without major modifications. Finally, if the score is within $0\% < x \leq 20\%$, it is categorized as Very Not Valid, showing that the product is completely unfeasible and must be redeveloped.

Table 3 Validation percentage category

Percentage	Category
$81\% < x \leq 100\%$	Very Valid
$61\% < x \leq 80\%$	Valid
$41\% < x \leq 60\%$	Enough Valid
$21\% < x \leq 40\%$	Not Valid
$0\% < x \leq 20\%$	Very Not Valid

2.4. Analysis of Student Learning Outcomes

In this research, Student Learning Outcomes can be measured based on the cognitive and psychomotor abilities of each student. For each ability, normality tests and paired t-tests.

2.4.1. Normality Test

The normality test is conducted to determine whether the research data has a normal distribution, as the presence of a normal distribution is an important requirement in further data analysis, The normality test is a procedural step used to evaluate whether the data originates from a population with a normal distribution (Asmara et al., 2023). In this study, the Shapiro-Wilk test was chosen for the normality test due to its high statistical power and suitability for small sample sizes, as the sample size is less than 100.

2.4.2. Hypothesis Test

The paired sample t-test was used in this study because it involved both pre-test and post-test measurements. The hypotheses used in this study are:

H0: There is no improvement in student competence in the Network System Administration subject using the "Sinawang" plugin with the application of Moodle-based Project-Based Learning (PjBL).

H1: There is an improvement in student competence in the Network System Administration subject using the "Sinawang" plugin with the application of Moodle-based Project-Based Learning (PjBL).

3. Results and Discussion

3.1. "Sinawang" Development Results

The Development stage focuses on the creation and development of the "Sinawang" plugin in alignment with the curriculum and the designed learning objectives. This process involved iterative testing and refinement to optimize the plugin's functionality and user experience ultimately aiming to enhance student engagement and learning outcomes.

3.1.1. Define

The Define stage involves establishing development requirements, focusing on four main analyses: front-end, concept, task, and instructional objectives. Front-end analysis identifies the need for a Moodle-based plugin to enhance student engagement in Network System Administration learning. Concept analysis outlines key topics, such as DHCP Server installation and configuration. Task analysis details learning objectives and content indicators. Finally, the instructional objectives specify expected student outcomes, including understanding DHCP Server basics, installation steps,

and application in real-world network management. This stage forms the foundation for developing an interactive and accessible learning tool.

3.1.2. Design

The design stage involves creating the web-based learning media. At this stage, the design of the "Sinawang" plugin is developed and presented using use case diagram and mockup. The Sinawang Plugin and Moodle LMS use case diagram, as shown in Figure 3, illustrates the roles and interactions within the system. The admin handles administrative tasks such as creating accounts and setting up classes. Teachers log in to add learning materials, set up project plans, assign tasks, and input grades. Students enroll in classes, access materials, follow project plans, complete assignments, and view grades. Solid lines represent direct interactions between actors and the system, while dashed lines indicate dependencies between use cases.

This system facilitates content management, assignment tracking, and project-based learning. Admins and teachers manage class creation and upload resources, ensuring students have structured access to educational content. Teachers assign tasks, which students complete and receive evaluations for, enhancing the feedback process. Project plans support structured learning, allowing students to track project requirements and timelines within the system. The plugin integrates smoothly with Moodle, promoting interactive and continuous learning.

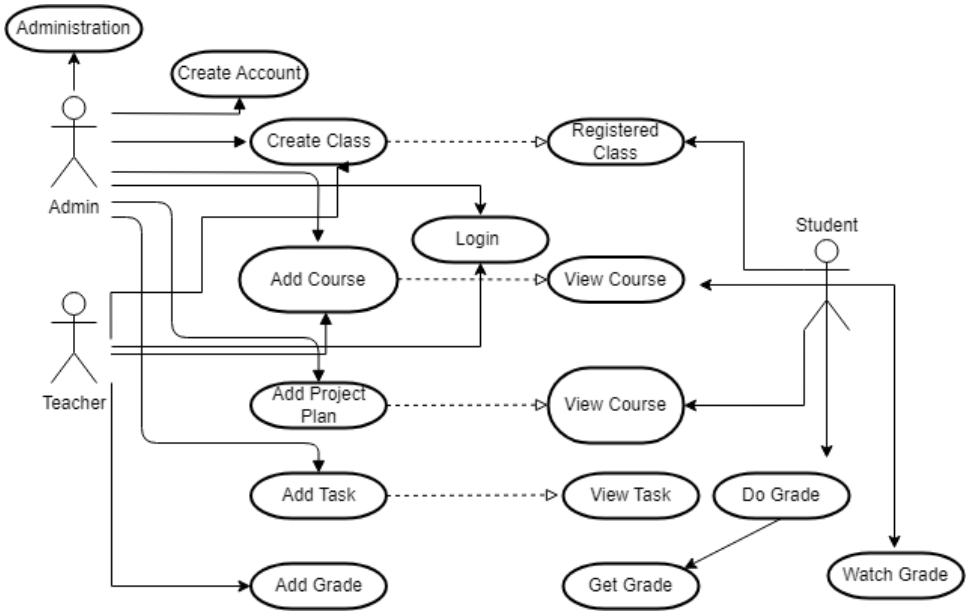

Figure 3 Use case diagram

The Student Learning Plan Competency List page, as illustrated in Figure 4, displays a detailed list of competencies registered in the learning plan template followed by students. The page includes navigation buttons such as "Kembali" (Back), access to the main page, and options to switch profiles. Key features include the "Bulk Rating" option for efficient evaluation and tabs for "Detail Kompetensi" (Competency Details), "Laporan" (Report), and "Rangkuman" (Summary). The competency list is presented in a table format with two main columns: "Nama Kompetensi Rencana Pembelajaran" (Competency Name) and "Rating Kompetensi Rencana Pembelajaran" (Competency Rating).

Clicking on a competency name reveals a carousel view with detailed information, as shown in Figure 5, including the total number of courses rated competent, a pie chart of course rating distribution, and the overall rating status.

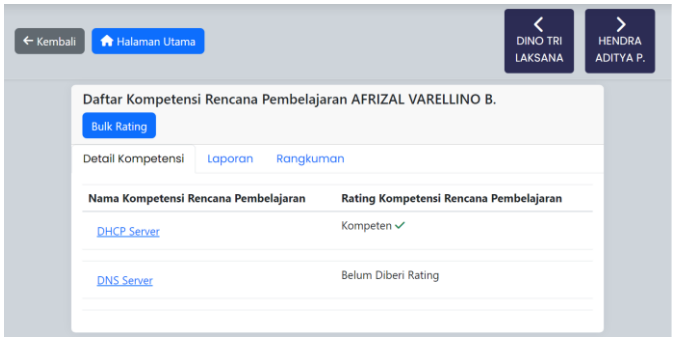

Figure 1 Student learning plan competency list page

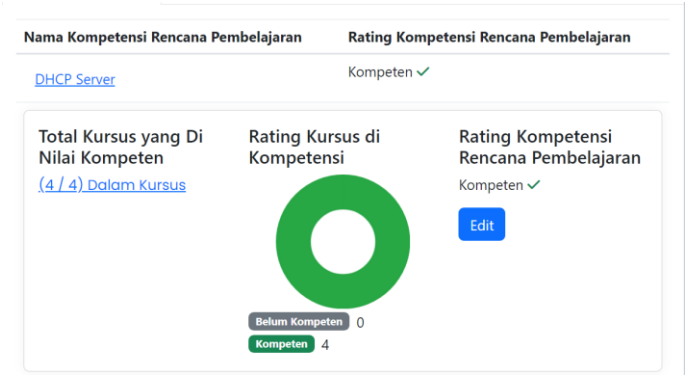

Figure 2 Detail competency learning plans.

3.1.3. Develop

In the Develop stage, the Sinawang plugin for Moodle was created, followed by a thorough feasibility evaluation. The validation process involved assessments of media, questions, instructional materials, and lesson plans (RPP). These assessments were conducted by experts, including university lecturers and a high school teacher specializing in network system administration.

The validation results demonstrated high validity across various components. Media validation scored 88.54%, lesson plan validation (RPP) scored 83.33%, instructional material validation scored 80.56%, and question validation scored 83.13%. This positive feedback confirmed that the plugin meets educational standards and is suitable for implementation.

After validation, the plugin was trialed with a sample of 40 students in an XI TKJ class at SMKN 1 Kediri. Pre-test and post-test assessments were administered to measure both cognitive and psychomotor skills.

The results indicated significant improvements: the average cognitive score increased from 52.8 (pre-test) to 86.6 (post-test). Similarly, the average psychomotor score improved from 74.5 to 85.9, demonstrating the plugin's effectiveness in enhancing student competencies in network system administration.

In the Develop stage, the Sinawang plugin for Moodle was created and underwent a thorough feasibility evaluation. The validation process involved assessments of media, questions, instructional materials, and lesson plans (RPP) by experts, including university lecturers and a high school teacher specializing in network system administration. The validation results demonstrated high validity across various components, as follows:

a. Media Validation (88.54%). Using 12 assessment indicators rated by two validators, the media achieved a validity score of 88.54%, calculated as:

$$Validity\ Percentage\ \% = \frac{85}{96}\ x\ 100\ \% = 88{,}54\ \%$$

b. Lesson Plan (RPP) Validation (83.33%). Using 12 assessment indicators rated by two validators, the RPP achieved a validity score of 83.33%, calculated as:

$$Validity\ Percentage\ \% = \frac{80}{96}\ x\ 100\ \% = 83.33\ \%$$

c. Instructional Material Validation (80.56%). Using 18 assessment indicators rated by two validators, the instructional material achieved a validity score of 80.56%, calculated as:

$$Validity\ Percentage\ \% = \frac{116}{144}\ x\ 100\ \% = 80.56\%$$

d. Question Validation (83.13%). Using 20 assessment indicators rated by two validators, the questions achieved a validity score of 83.13%, calculated as:

$$Validity\ Percentage\ \% = \frac{133}{160}\ x\ 100\ \% = 83.13\%$$

3.1.4. Disseminate

The Disseminate stage involves distributing the Sinawang plugin for Moodle. First, open the link provided by the researcher (https://github.com/muslichwr/sinawang), which directs you to the researcher's GitHub repository. Locate the file named sinawang.rar and click on it to access a separate page displaying the file contents or a "view raw" option. In the top right corner of this page, click the download icon to save the plugin file to your computer.

Once downloaded, extract the plugin into your Moodle folder, specifically in the report directory. Finally, refresh the Site Administration page in Moodle to install the plugin, ensuring you are logged in as a root or administrator user.

3.2. Validation results

The validation of the "Sinawang" as learning media plugin was conducted by lecturers from the Department of Informatics Engineering at Surabaya State University, along with teachers from the Computer and Network Engineering Department of SMK Negeri 1 Kota Kediri. This validation process utilized instruments consisting of validation sheets for Lesson Plans (RPP) or teaching modules, learning materials, instructional media, and post-test questions. Experts carried out a comprehensive evaluation of various components, including media content, teaching materials, lesson plans, and assessment questions, to ensure that all elements adhere to established standards of eligibility.

Overall, the validation results indicate that the "Sinawang" learning media plugin and its associated components exhibit high quality and are highly suitable for enhancing students' Arduino programming skills. The results also demonstrate the reliability of this media as a tool in the learning process. The summary of validation results by the experts is presented in Table 4.

Table 4 Validation results

Validation assessment	Validity	Description
RPP	83,3%	Very Valid
Media	88,54%	Very Valid
Materials	80,56%	Valid
Quiz	83,13%	Very Valid

3.3. Student learning outcomes test results

3.3.1. Cognitive test results

A key finding that highlights the success of this research is the analysis of the paired t-test results, showing a significant increase in students' scores. The average pretest score for students was 52.8,

while the average posttest score rose to 86.6. This data indicates that the cognitive posttest scores of students were notably higher than their pretest scores (86.6 > 52.8), demonstrating a marked improvement following the intervention.

A. Normality test

The analysis shows that the pre-test and post-test data are normally distributed, as evidenced by SPSS calculations yielding significance values (sig.) of 0.065 and 0.063, both greater than 0.05. Thus, the cognitive test data for pre-test and post-test are considered normally distributed. supporting the validity of the results of the statistical analysis conducted in this research.

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
pretest	.143	40	.039	.948	40	.065
posttest	.132	40	.076	.948	40	.063

a. Lilliefors Significance Correction

Figure 3 Normality test result for cognitive abilities

B. Paired T-test

The calculation of the Paired Sample T-Test for cognitive data resulted in a p-value of < 0.001. Since the p-value is smaller than the significance level of 0.05, H0 is rejected, and H1 is accepted. shown in Figure 7.

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	pretest - posttest	-33.800	9.368	1.481	-36.796	-30.804	-22.820	39	<,001

Figure 4 Paired T-Test result for cognitive abilities

3.3.2. Psychomotor test results

The psychomotor learning outcomes test was conducted to evaluate students' ability to show skill in networking debian. The average pretest score was 74.5, while the average posttest score increased to 85.9. This demonstrates that students' psychomotor posttest scores were higher than their pretest scores (85.9 > 74.5).

A. Normality test

The analysis indicates that the psychomotor pre-test and post-test data are normally distributed. This is demonstrated through SPSS calculations, which yielded significance (sig.) values of 0.009 and 0.063, both greater than 0.05. Therefore, the psychomotor test data for the pre-test and post-test are considered normally distributed. The results of the psychomotor normality test are shown in Figure 8:

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
pretest	.168	40	.006	.922	40	.009
posttest	.192	40	<,001	.917	40	.006

a. Lilliefors Significance Correction

Figure 5 Normality test result for psychomotor abilities

B. Paired T-test

The results of the Paired Sample T-Test for the psychomotor test showed a p-value of < 0.001. Since the p-value is smaller than the significance level of 0.05, H0 is rejected, and H1 is accepted. Figure 9 is the result of the psychomotor paired T-Test.

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	pretest - posttest	-11.400	1.446	.229	-11.863	-10.937	-49.845	39	<,001

Figure 6 Paired T-Test result for psychomotor abilities

4. Conclusions

Based on the findings obtained during the research activities, the following conclusions can be drawn. The design and development of the "Sinawang" plugin, incorporating Moodle-based Project-Based Learning (PjBL) to enhance Network System Administration competencies for TKJ students, utilized the 4D model (Define, Design, Develop, Disseminate). The plugin achieved a high validity level, scoring 88.54%, which indicates that the "Sinawang" plugin is suitable for implementation to improve the skills of vocational students. The plugin successfully functions as a learning plan management tool, effectively supporting the learning process by enabling teachers to organize course materials, assign projects, and track student progress systematically. Its high validity scores across media (88.54%), lesson plans (83.33%), instructional materials (80.56%), and questions (83.13%) confirm its alignment with educational standards.

The integration of the "Sinawang" plugin in a PjBL model through Moodle proved effective in enhancing student competencies in Network System Administration. Moodle's effectiveness is demonstrated through its accessibility, providing a centralized platform for students to access learning materials, submit assignments, and receive feedback efficiently, as well as fostering collaboration between students and teachers during project-based tasks. The average pre-test and post-test scores for cognitive assessment were 52.8 and 86.6, while for psychomotor assessment, they were 74.5 and 85.9, respectively. Hypothesis testing using a paired sample t-test for both cognitive and psychomotor tests indicated a significant improvement in student competencies, with a Sig. (2-tailed) value of 0.001 < 0.05. According to the decision-making criteria in the paired sample t-test, it is concluded that (H0) is rejected, and (H1) is accepted, meaning that there is a significant improvement in student competence in Network System Administration through the use of the "Sinawang" plugin with Moodle-based PjBL.

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