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Digital Transformation in Vocational Education: Development and Evaluation of a Project-Based E-Jobsheet for LAN Installation Integrated with Google Workspace

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ABSTRACT

Vocational education must equip students with practical competencies aligned with the digital and Fourth Industrial Revolution era. However, learning in vocational schools often faces limitations, including scarce digital media resources, weak integration of real-world projects, and minimal use of collaborative technologies. This study aimed to develop and evaluate a Project-Based E-Jobsheet for Local Area Network (LAN) installation integrated with Google Workspace to enhance learning in Computer and Network Engineering programs. The research employed the 4D development model: Define, Design, Develop, and Disseminate. Instrument validation was conducted using Aiken's V, while practicality and effectiveness were assessed through user responses and learning outcome analysis. The E-Jobsheet demonstrated high validity in terms of media (0.836), content (0.809), and language (0.909). Practicality testing yielded a score of 85.36%, categorized as "very practical." Effectiveness analysis showed a significant improvement in student learning outcomes ($p = 0.003$). Integration with Google Workspace tools (Docs, Sheets, and Forms) enabled efficient collaboration, structured feedback, and digital assessment. The findings indicate that the Project-Based E-Jobsheet is valid, practical, and effective in enhancing student engagement and learning outcomes. It supports constructivist learning through active, collaborative, and project-based approaches. Despite limitations such as single-site implementation and reliance on internet access, this study offers an adaptive digital solution to improve vocational education and better prepare students for technological advancements.

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1. INTRODUCTION

Vocational High Schools (VHS) have an important role in preparing this quality human resources in different professional fields (Rosana et al., 2025; Yoto et al., 2024). According to the regulation (the Government Regulation No 29 of 1990), vocational education is defined as: Education carrying a content that directed at developing attitudes, skills and knowledge required for working in certain occupations. Therefore, SMK give more emphasis to both types of skills by adjusting the curriculum with industry demand. To increase the readiness for professionalism, the majority of SMKs have turned into SMK LSP licensed by BNSP (The National Professional Sertification Agency) in which graduates were awarded Vocation Certificate can get a national standard certificate (Andriam, 2021; Kamaludin, 2024).

One of the competence in Vocational Education is Computer and Network Engineering, which aims to provide great technical skills in computer network. For the fundamental skills, Local Area Network (LAN) installation is a prerequisite of students being prepared for professional certification exams (Johnson, 2024). This subject goes beyond concepts to hands-on practice – planning, configuring, and testing network connectivity (Goni, 2021; Suhendra et al., 2024; Johnshon, 2024). Effective mastery of LAN installation competencies requires structured training, clear procedural guidelines, and opportunities for independent and collaborative learning.

The results of observations and interviews conducted at the TJKT Department of SMK Negeri 1 Singingi Hilir show critical problems in LAN installation learning. Practical activities are still very dependent on teacher explanations, students have difficulty learning independently, and collaborative learning is not yet supported by digital platforms. The available printed job sheets are often incomplete, damaged, or lost, and do not contain clear procedural steps. As a result, students are heavily dependent on random video tutorials on the internet that do not support a deep procedural and conceptual understanding. In addition, the learning outcome data shows that only 42% of students have achieved the minimum competency standard in LAN installation material, indicating a serious gap between conceptual mastery and practical skills.

Previous studies have shown the effectiveness of using e-jobsheets in vocational and technical education. Study of Sholichah & Arifiana (2024) in fashion design, Widyastuti et al. (2023) object-oriented programming and Labib et al. (2023) and all showed noticeable enhancement of students' learning effects, motivations, and autonomies. However, to date, there has been very limited research integrating project-based learning (PjBL), cloud-based collaboration platforms, and LAN installation learning in an integrated manner in the context of vocational schools in Indonesia. Most previous studies have only examined these components separately. This indicates a clear research gap regarding the development of collaborative project-based e-jobsheets for network installation competencies.

To address these issues, this study developed a project-based e-jobsheet for LAN installation practice integrated with Google Workspace to support structured practice, real-time collaboration, and learning performance monitoring. The use of Google Classroom, Google Forms, and Google Sheets enables collaborative and systematic interaction, feedback, and task management. Google Workflow opens the door to more flexible access to learning materials, and makes collaboration easier and increases digital literacy in students. Although there are difficulties in terms of internet connection, the use of platform has an overall benefit to encourage interaction and organized learning activities; which further makes it quite a relevant tool for vocational digital transformation (Maison et al., 2024; Rubio & Rodríguez, 2023)

Therefore, this study aims to answer the following research questions: (1) How valid and practical are project-based electronic worksheets integrated with Google Workspace for LAN installation in improving the learning process in vocational schools? (2) How effective is the use of these electronic worksheets in improving independent and collaborative learning skills and student learning outcomes?

2. METHODS

2.1. Research Design

This research is a research and development (R&D) project that aims to produce innovative learning products in the form of Project-Based Learning (PjBL)-based E-Jobsheets for local area network (LAN) installation material with Google Workspace integration to improve students' practical skills and independent learning. The development was carried out using the 4-D model (Define, Design, Develop, Disseminate) (Thiagarajan, 1974). This model was chosen because it is systematic and structured in producing valid, practical, and effective products. The research stages include analyzing student needs and characteristics (define), designing e-jobsheets (design), expert validation and limited testing (develop), and disseminating the product for wider implementation (disseminate). This approach not only produces applicable digital learning media but also provides empirical contributions to improving the effectiveness of practical learning in vocational education.

2.2. Participants

The subject of this study was the LAN Network Installation E-Jobsheet, which was developed as an innovative digital learning medium for the Computer Network and Telecommunications Engineering (TJKT) program. The product was evaluated in terms of its feasibility, practicality, and effectiveness in supporting practical network installation learning. The research participants consisted of eleventh-grade TJKT students selected using a quasi-experimental non-randomized sampling technique (Labordo Jr, 2024). The experimental group comprised 25 students from SMKN 1 Singingi Hilir, who learned using a Project-Based Learning (PjBL)-based E-Jobsheet integrated with Google Workspace, while the control group consisted of 29 students from SMKN 1 Kuantan Mudik, who learned using conventional printed jobsheets. Group assignment was not conducted randomly because intact classes from different schools were used to preserve the natural learning context, resulting in a total of 54 participants.

In addition to the main research groups, this study involved Class XI-2 of SMKN 1 Kuantan Mudik as a pilot class to test the validity and reliability of the research instruments, including pretest and posttest items and practicality questionnaires. Instruments that did not meet the validity and reliability criteria were revised or replaced before being applied in the experimental and control classes during the effectiveness testing phase. This study was conducted after obtaining official permission from the respective school authorities, and informed consent was obtained from students and teachers. All participants were assured that their participation was voluntary, their identities would remain anonymous, and the collected data would be used solely for research purposes. To minimize potential selection bias, the equivalence of the experimental and control groups was examined through pretest score analysis prior to the intervention.

2.3. Instruments and Data Collection Techniques

This study employed research instruments designed to collect data on the validity, practicality, and effectiveness of Google Workspace–integrated, Project-Based Learning (PjBL) e-jobsheets for LAN network installation practical learning. Data were collected using expert validation questionnaires, student response questionnaires, observation sheets, and learning outcome tests. The questionnaires were used for expert validation, practicality assessment, and student responses, while the learning outcome tests were used to measure the effectiveness of the media in improving students' cognitive understanding and practical skills.

Product validity was evaluated by three groups of experts: subject matter experts, media experts, and language experts. Subject matter experts assessed content relevance, technical accuracy, and alignment with the TJKT curriculum and PjBL principles. Media experts evaluated interface layout, navigation, accessibility, and interactivity of the e-jobsheet, while language experts examined clarity of instructions, consistency of terminology, and readability. Each expert completed a structured

validation questionnaire developed from established instructional media evaluation indicators, and the validation results were used as the basis for product revision prior to field testing.

The practicality of the e-jobsheet was assessed using student response questionnaires and learning implementation observation sheets. The questionnaire consisted of Likert-scale items measuring ease of use, perceived usefulness, attractiveness, and support for project-based learning activities. Meanwhile, the effectiveness of the media was measured using a pretest–posttest design. The learning outcome test consisted of 30 multiple-choice items and 5 short-answer practical analysis items, covering topics of LAN topology, cable types, crimping procedures, IP addressing, and basic network troubleshooting. The reliability of the learning outcome test was examined using Cronbach's Alpha, yielding a reliability coefficient of $\alpha = 0.87$, which indicates high internal consistency. Improvement in learning outcomes was analyzed by comparing pretest and posttest scores, thus providing empirical evidence of the impact of the e-jobsheet on students' learning achievement.

2.4. Research Procedures

The development procedure used in this study refers to the 4-D (Four-D Models) development model developed by Thiagarajan (Muskhir et al., 2023). This model consists of four main stages, namely define, design, develop, and disseminate. Each stage has a systematic role in producing valid, practical, and effective learning products. In more detail, the research procedure flow that describes the stages of development implementation can be seen in Figure 1.

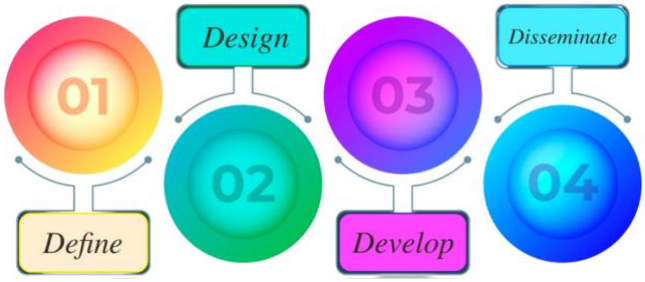


Figure 1. The steps of research and development of the 4D model

The process of developing Project Based Learning-based learning media using the 4D model includes four stages, namely Define, Design, Develop, and Disseminate. In the Define stage, an initial analysis of learning needs in the TJKT vocational program at SMK Negeri 1 Singingi Hilir was conducted through observation and interviews with teachers. Analysis of the curriculum, student characteristics, and materials showed the need for interactive digital media to support understanding and practice of LAN installation relevant to industry needs. The results of the analysis were used to formulate learning objectives that emphasized students' ability to understand concepts, perform installations independently, and apply industrial work procedures.

Next, the Design stage produced a preliminary design for an interactive e-jobsheet based on Google Workspace that combines text, images, and collaborative elements to support independent learning. The Develop stage included a validation process by experts in subject matter, media, and language, followed by revisions and limited trials with 11th grade TJKT students. The trial results showed that the media was valid, practical, and effective in increasing student independence and understanding. In the Disseminate stage, the product was widely socialized and tested among teachers and students, accompanied by training on its use so that it could be integrated into the practical learning process. The final results showed that the e-jobsheet was suitable for use as an innovative digital learning medium in the field of Computer Network Engineering and Telecommunications.

2.5. Data Analysis

This study employed both descriptive and inferential statistical analyses to examine the validity, practicality, and effectiveness of the developed Project-Based E-Jobsheet for LAN installation integrated with Google Workspace. The analysis process was carried out in three main stages: (1) assessing the media validity through expert evaluation, (2) measuring the practicality and usability based on teacher and student responses during implementation, and (3) determining the effectiveness of the E-Jobsheet in improving students' learning outcomes within the Project-Based Learning (PjBL) framework.

2.4.1 Analysis of Validity

The data analysis technique for validity testing in this study used Aiken's V index, which serves to assess the content validity of an instrument based on the results of expert assessment. This index is calculated by comparing the expert assessment scores to the scale used to assess the suitability of each item in the instrument. Aiken's V is calculated by summing the adjustment scores from the experts, then dividing by the product of the number of assessors and the assessment scale range. The Aiken's V value ranges from 0 to 1, with a criterion of $V \geqslant 0.80$ indicating a high level of validity and the item being declared suitable for use, while $V < 0.40$ indicates a low level of validity and requires revision. The formula for calculating Aiken's V is shown in Equation 1 (Muskhir et al., 2024).

$$V = \frac{\sum s}{[n(c-1)]} \qquad (1)$$

Description:
s = r - I_0
l_0 = Lowest validity score
c = Highest validity score
r = Score given by validator
n = Number of validators

2.4.2 Analysis of Practicality

Practicality data analysis was conducted using a percentage analysis technique for each practicality assessment item. The assessment was conducted on each item based on the number of users. The results of the practicality interval categories can be seen in Table 1 (Muskhir et al., 2023).

$$V = \frac{\sum x\ expert}{x\ max}\ x\ 100\% \qquad (2)$$

Table 1. Practicality Category Interval

Interval (%)	Category
81% - 100%	Very Practical
61% - 80%	Practical
41% - 60%	Quite Practical
21% - 40%	Less Practical
0% - 20%	Not Practical

2.4.3 Analysis of Effectiveness

An effectiveness analysis was conducted to measure the extent to which the use of Project-Based Learning (PjBL)-based e-jobsheets influenced student learning outcomes compared to the use of conventional jobsheets. The test was conducted by comparing the pre-test and post-test scores between the experimental class and the control class. To ensure the validity of the analysis results, the data were tested through three statistical stages, namely normality test, homogeneity test, and t-test, with the help

of SPSS version 25 software. The normality test was performed using the Shapiro-Wilk Test because the sample size was less than 50 students, making it more sensitive to detect deviations in data distribution in small to medium sample sizes. The data was declared normally distributed if the significance value (Sig.) was greater than 0.05, while a Sig. value < 0.05 indicated that the data was not normally distributed. The results of this test were used as the basis for determining the appropriate type of statistical analysis in the next stage.

Next, a homogeneity test was conducted to ensure that the variance in learning outcomes between the experimental and control classes was homogeneous. Variance homogeneity is important to ensure that the differences in average learning outcomes that arise are not caused by differences in data distribution, but purely due to different learning treatments. The test used Levene's Test of Equality of Variances with a significance level (α) = 0.05, where a Sig. > 0.05 indicates homogeneous data. After the assumptions of normality and homogeneity were met, an Independent Sample T-Test was conducted to determine the significance of the difference in learning outcomes between the two groups. The experimental class used PjBL-based e-jobsheets integrated with Google Workspace, while the control class used conventional print-based jobsheets. The t-test results with a Sig. (2-tailed) < 0.05 criterion showed a significant difference between the two groups, indicating that the use of e-jobsheets was effective in improving student learning outcomes in LAN installation practice learning.

3. FINDINGS AND DISCUSSION

3.1. Findings

Based on the development stages that have been carried out, this research has produced a Project-Based Learning-based LAN network installation e-jobsheet product integrated with Google Workspace, aimed at Computer Network and Telecommunications Engineering skills competencies. This product was developed by adapting the 4D learning media development model (Define, Design, Develop, and Disseminate), which includes a systematic series of processes ranging from needs analysis, media design, product development, to the dissemination stage to ensure its feasibility and effectiveness in practical learning.

3.1.1 Define Stage

The Define stage aims to identify learning needs and formulate development objectives for a Project-Based Learning-based LAN network installation e-jobsheet integrated with Google Workspace. This process involves five main steps: initial analysis, curriculum analysis, student characteristics analysis, material analysis, and formulation of learning objectives.

The initial analysis was conducted through classroom observation, teacher interviews, and review of learning documents to identify the main problems in LAN network installation practical learning. It was found that the learning process was still teacher-centered and the use of conventional jobsheets resulted in low student participation and learning outcomes (42% completion rate out of 25 students). Next, a curriculum analysis was conducted to ensure the suitability of the material with the basic competencies in the Computer Network Engineering and Telecommunications subject in phase F of the Merdeka Curriculum, particularly in the elements of planning, addressing, and installing wired and wireless networks.

Analysis of student characteristics showed that the majority of students had visual and kinesthetic learning styles with high motivation for project-based activities. Therefore, the e-worksheet was designed with attractive visuals, interactive instructions, and collaborative activities. The material analysis focused on essential topics, such as making straight and cross cables, configuring IP addresses, and sharing files between computers, which are relevant to industry needs. Based on the results of this analysis, learning objectives were formulated to cover cognitive, affective, and psychomotor aspects so that students are able to understand concepts, master technical skills, and demonstrate a professional attitude in LAN network installation practices.

3.1.2 Design Stage

The Design stage is the initial design phase of learning media based on the results of the needs analysis in the Define stage. The main focus of this stage is to design an initial prototype of a Project-Based Learning-based LAN installation e-jobsheet integrated with Google Workspace. The design was carried out through four main steps, namely the preparation of assessment instruments, media selection, format selection, and initial design preparation. Research instruments in the form of questionnaires and objective tests were developed to assess the validity, practicality, and effectiveness of the product. The test results showed that the questionnaire instrument had very high validity with a Gregory coefficient value (V = 1) and high reliability (PA = 90%), making it suitable for data collection.

The selection of media was based on the learning characteristics at SMKN 1 Singingi Hilir, which required digital collaboration and flexibility in learning time. Google Workspace was chosen as the main platform because it supports an integrated online learning ecosystem through Google Forms, Google Docs, and Google Sheets with the Autocrat extension for automating work reports. The e-jobsheet format was designed with a web-based interface using Canva Web to make it attractive, interactive, and easily accessible on various devices. The content structure includes a main page, usage guide, learning outcomes, materials, practice worksheets, work results, and developer profiles. The initial product design was developed with consideration for content integration, ease of navigation, and support for collaborative and independent learning. The following is the e-jobsheet design consisting of the following components:

1) Home Page and User Guide

The main page (homepage) serves as the opening display and navigation center for all e-jobsheet content, displaying the media title, subject identity, and main menu that directs users to other sections such as usage instructions, learning outcomes, materials, practice worksheets, practice results, and developer profiles. The design of this page is simple, interactive, and easily accessible so that students and teachers can easily navigate the available features, as shown in Figure 2 (a). Meanwhile, the instructions page contains step-by-step guidance on how to operate the e-jobsheet, from opening the main page, accessing materials, filling out the jobsheet, to uploading practice results. This guide is systematically arranged so that users, both teachers and students, can understand and utilize the e-jobsheet independently and effectively in accordance with the learning procedures, as shown in Figure 2 (b).

(a) Main Menu (b) Display of user guide

Figure 2. Display of Main Menu and User Guide

2) Learning Materials Page and Practical Work Sheet

The learning materials page serves as the main digital learning resource that provides supporting materials for LAN network installation practices. The content covers basic computer network concepts, an introduction to network devices, and the functions and characteristics of various types of UTP cables that comply with vocational standards. The material is systematically organized in various formats, such as narrative text, illustrations, and interactive learning video links to reinforce students'

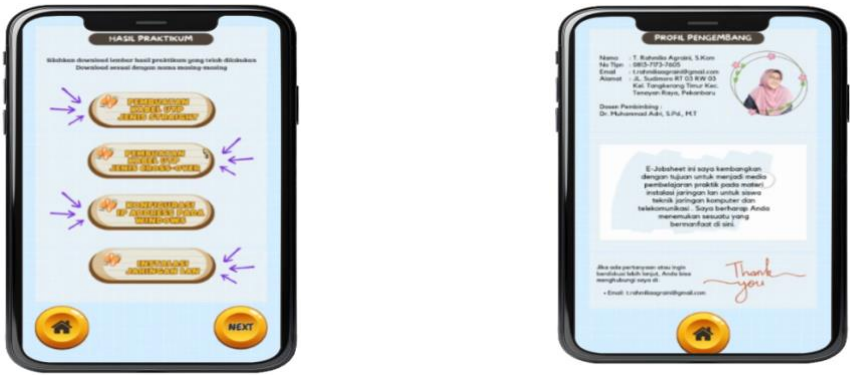
understanding before carrying out the practice, as shown in Figure 3 (a). Meanwhile, the practicum jobsheet page is the core of the e-jobsheet, which contains digital worksheets for students. This section contains work steps, a list of tools and materials, and space to record observations and practical activities. Digital forms are integrated through Google Docs and Google Forms so that students' work results are automatically documented and can be accessed by teachers in real-time. There are four main practical activities designed based on basic LAN network installation competencies, where each activity is equipped with interactive links to digital worksheets to make it easier for students to follow procedures, fill in practical results, and document activities directly in digital format, as shown in Figure 3 (b).

(a) Display of Learning Material (b) Display of practical worksheet

Figure 3. Display of Learning Material and Practical Worksheet

3) Practicum Results Page and E-Jobsheet Developer Information

The practicum results page serves as a digital documentation center that displays students' work after completing the LAN network installation practicum. Through the integration of Google Forms and Google Sheets, all data collected from the online form is automatically summarized and processed using the Autocrat extension to generate a digital report of the practicum results. This page contains four main sections of the practicum results that students can access through interactive links based on the title of each activity, as shown in Figure 4 (a). Furthermore, the developer info page contains a brief profile of the media developer, including their identity, background, and objectives for developing a Google Workspace-integrated Project Based Learning-based e-jobsheet. In addition, this page also provides contact information that can be contacted as a form of transparency and further development of the learning products that have been produced, as can be seen in Figure 4 (b).



(a) Display of Practicum Results (b) Display of E-jobsheet Developer

Figure 4. Display of Practicum Result and E-jobsheet Developer

3.1.3 Development Stage

The development stage is a continuation of the design stage, which focuses on realizing the e-jobsheet product for LAN network installation based on Project Based Learning integrated with Google Workspace as a valid, practical, and effective learning medium. In this stage, the initial prototype that was designed earlier is developed into the final product through a systematic quality testing process, including expert validation, instrument reliability testing, practicality testing by users, and effectiveness testing in practical learning at SMK Negeri 1 Singingi Hilir..

1) Validity Test Data

The validity test of the instrument and product of the Project Based Learning-based LAN network installation e-jobsheet integrated with Google Workspace is an important stage to ensure the feasibility of the product before it is tested on students. This validity test aims to assess the extent to which the developed media meets the suitability of the material content, learning design principles, and linguistic rules. The validation process was carried out by nine experts, consisting of three media validators, three material validators, and three language validators, all of whom were lecturers and experienced teachers with competencies in their respective fields of expertise. Table 2 shows the results of the validity test of the e-jobsheet for LAN network installation based on Project Based Learning integrated with Google Workspace.

Table 2. Validity Test Data Results

Validation	Indicator	Aiken's V Score	Criteria
Media	Media Design	0,917	Valid
	Multimedia Learning	0,796	Valid
	Constructivism	0,917	Valid
	Interface (UI/UX)	0,861	Valid
	Navigation	0,833	Valid
	Visual and Audio Quality	0,778	Valid
	Accessibility & Usability	0,800	Valid
	Average	**0.836**	**Valid**
Material	Curriculum alignment	0,792	Valid
	Technical accuracy of materials	0,867	Valid
	Completeness of e-jobsheet components	0,810	Valid
	Depth and breadth of materials	0,708	Valid
	Alignment with PjBL principles	0,806	Valid
	Average	**0,809**	**Valid**
Language	Accuracy of Terms	0,917	Valid
	Relevance to Users	0,861	Valid
	Effectiveness of Sentences	0,944	Valid
	Readability of Text	0,971	Valid
	Average	**0,909**	**Valid**

In general, the validity test results indicate that the developed e-jobsheet has met the eligibility criteria in terms of media design, content quality, and language that are appropriate for project-based learning in vocational education. Media expert validation obtained an average score of V = 0.836, indicating that the appearance, interface (UI/UX), navigation, and visual and audio quality have met the principles of good learning media design. The media is considered interactive, easy to use, and capable of increasing student engagement in the learning process. Meanwhile, the results of material expert validation with an average score of V = 0.809 indicate that the content of the e-jobsheet is in line

with basic competencies, conceptual accuracy, and project-based learning principles. The material was considered complete, relevant to the vocational context, and supportive of achieving the learning objectives of LAN installation practice. From a linguistic perspective, the language expert validation results obtained the highest score of V = 0.909, which falls into the highly valid category. This score indicates that the language used in the e-jobsheet is communicative, easy to understand, and in accordance with good linguistic rules. The technical terms used were also considered appropriate and contextual to the field of Computer and Network Engineering. Thus, overall, the developed e-jobsheet was declared valid and suitable for use as an innovative digital learning medium to support the implementation of Project-Based Learning in vocational schools.

2) Practicality Data Test

A practicality test was conducted to assess the ease of use, comprehensibility, and usefulness of the Google Workspace-integrated Project Based Learning-based LAN network installation e-jobsheet in the context of practical learning. This test involved direct users, namely 11th grade TJKT students at SMK Negeri 1 Singingi Hilir, as the main respondents. The purpose of this practicality test was to determine the extent to which the e-jobsheet could be used easily, understood clearly, and able to support the implementation of LAN network installation practice independently, purposefully, and effectively in accordance with the principles of project-based learning. Figure 4 shows the results of the practicality test related to the e-jobsheet for LAN network installation based on Project Based Learning integrated with Google Workspace.

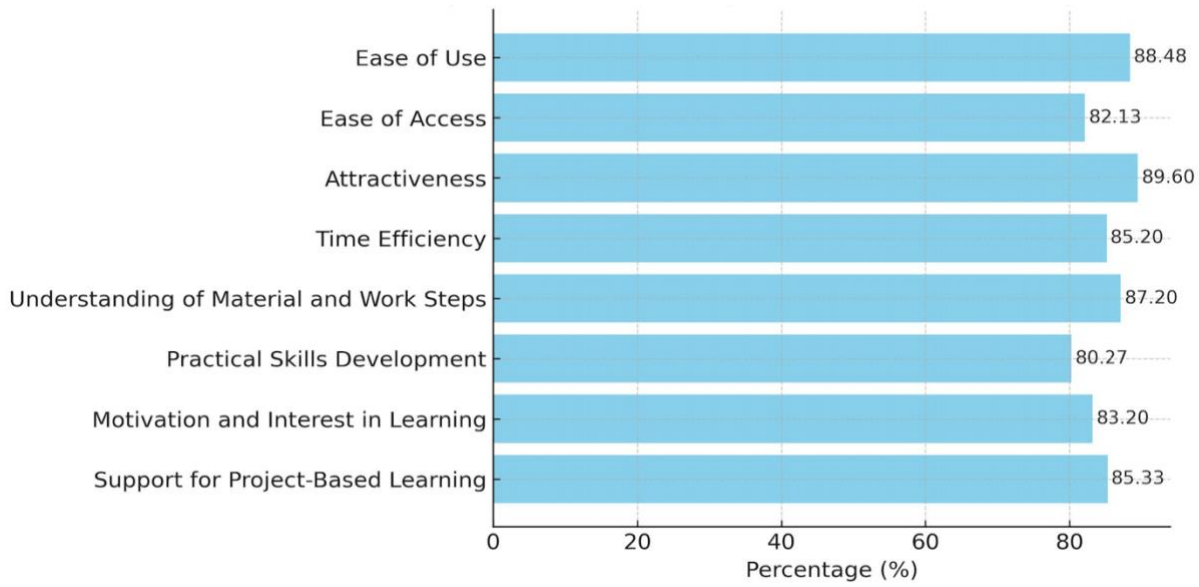


Figure 5. Practicality Test Data Results

Based on the practicality test results shown in Figure 5, a high average percentage was obtained for all assessment indicators. Practicality data was collected through a Likert scale questionnaire given to students. The analysis results showed an average score of 85.36%, which is in the "very practical" category. The attractiveness aspect received the highest score of 89.60%, followed by ease of use at 88.48%, and understanding of the material and work steps at 87.20%. The indicators of time efficiency (85.20%) and support for project-based learning (85.33%) also showed excellent results. Meanwhile, practical skill development received the lowest score of 80.27%, but still fell within the highly practical category. These results confirm that the e-jobsheet is considered easy to access, visually appealing, and effective in supporting student learning activities. Overall, the results show that the e-jobsheet medium has a very high level of practicality and is suitable for use in practical learning at SMK Negeri 1 Singingi Hilir.

3) Effectiveness Test Data

An effectiveness test was conducted to analyze the impact of using e-jobsheets for LAN network installation based on Project Based Learning (PjBL) integrated with Google Workspace on improving student learning outcomes. The main objective of this test was to determine the extent to which the use of e-jobsheets could improve students' conceptual understanding and practical skills compared to the use of conventional print-based jobsheets. The effectiveness of the media was evaluated in two stages to obtain a comprehensive analysis.

The first stage measured the level of improvement in student learning outcomes by comparing the pre-test and post-test results between the experimental class, which used e-jobsheets, and the control class, which used conventional jobsheets, as shown in Table 3. The analysis results show that the control class had an average score of 70.51 with a standard deviation of 12.27, while the experimental class had an average of 79.20 with a standard deviation of 6.72. When compared to the minimum passing grade of 70, the control class average only slightly exceeded the passing threshold with wide variation in results, while the experimental class showed much higher and more consistent achievements. These findings confirm that the use of PjBL-based e-jobsheets can improve students' conceptual understanding and practical skills more evenly in LAN network installation learning.

Table 3. Student Learning Outcomes

Group	Average	Standard Deviation	Highest Score	Lowest Score
Control	70.51	12.27	95	40
Experiment	79.20	6.72	90	65

In the second stage, an independent sample t-test was conducted to analyze the significance of the difference in learning outcomes between the experimental group (using e-jobsheets) and the control group (using conventional print-based jobsheets). The data was first analyzed to ensure that the assumptions of normality and homogeneity were met as prerequisites for the validity of the t-test. The combined results of these two analyses provided strong empirical evidence that the use of Google Workspace-integrated PjBL-based e-jobsheets had a significant effect on improving students' conceptual understanding and practical skills in learning LAN network installation at vocational schools.

The normality test was performed using the Shapiro-Wilk Test because the number of samples in each class was less than 50 students, with the criterion that the data was declared normal if the significance value (Sig.) > 0.05. Based on the normality test results in Table 4, the analysis shows that the posttest significance value for the control class is 0.123 and for the experimental class is 0.187, both of which are greater than 0.05. Thus, the learning outcome data from both classes are normally distributed, which means that the distribution of student scores is relatively even and meets the normality assumption for further statistical analysis.

Table 4. Normality Test Results

	Group	Kolmogorov-Smirnova			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Posttest	Control	.189	29	.010	.943	29	.123
	Experiment	.147	25	.169	.944	25	.187

In addition to the normality test, a homogeneity test was also conducted to ensure that the variance of learning outcomes between the experimental class and the control class was the same or not. This test used Levene's Test of Equality of Variances with a significance level of 0.05. The criteria used were that if the significance value (Sig.) was > 0.05, the data was considered homogeneous, whereas if the Sig. value was ≤ 0.05, the data was considered non-homogeneous. Based on the analysis results in Table 5, a significance value of 0.051 was obtained, which is greater than 0.05. This indicates that the variance in learning outcomes between the experimental class and the control class is homogeneous, or has

comparable similarities. Thus, both groups meet one of the prerequisites for the t-test, which is used to test the effectiveness of using e-jobsheets on student learning outcomes.

Table 5. Homogeneity Test Results

		Levene Statistic	df1	df2	Sig.
Posttest	Based on Mean	3.993	1	52	.051
	Based on Median	3.745	1	52	.058
	Based on Median and with adjusted df	3.745	1	39.166	.060
	Based on trimmed mean	4.199	1	52	.045

After fulfilling the assumptions of normality and homogeneity, a T-test was conducted to analyze the differences in student learning outcomes between the experimental class and the control class after being given different learning treatments. The purpose of this test was to determine whether the differences were statistically significant. The analysis used an Independent Sample T-Test with a significance level of 0.05. Based on the calculations in Table 6, a significance value (Sig. 2-tailed) of 0.003 was obtained, which is smaller than 0.05. This indicates that there is a significant difference in learning outcomes between the two groups. Thus, it can be concluded that the use of e-jobsheets has a positive and significant effect on improving student learning outcomes, especially in the subject of LAN network installation.

Table 6. Independent Samples Test Results

		F	Sig.	t	df	Sig. (2-tailed)
Posttest	Equal variances assumed	3.993	.051	-3.151	52	.003
	Equal variances not assumed			-3.282	44.575	.002

3.1.4 Disseminate Stage

The dissemination stage is the final phase in the development process of the Project-Based Learning (PjBL) integrated Google Workspace LAN installation e-jobsheet media. This stage aims to disseminate products that have been declared valid, practical, and effective to relevant parties in the vocational education environment. Dissemination activities are focused on teachers of the Computer Network and Telecommunications Engineering (TJKT) Program and the TKJ Teacher Subject Discussion Group (MGMP) community in Kuantan Singingi Regency as partners for field implementation.

The dissemination activity was held on October 10, 2025, in the form of socialization and training on the use of e-jobsheets, which included an explanation of the development concept, an explanation of the main features, and a demonstration of the application of media in LAN installation practice learning. Through this activity, teachers gained an understanding of how to access, manage, and integrate e-jobsheets into project-based learning, while MGMP participants gained insight into the application of digital media innovations to improve the effectiveness and quality of learning in vocational schools.

The results of the activity showed positive responses from all participants, especially in terms of ease of use, interface display, and the usefulness of media in supporting technology-based learning. This dissemination stage is the first step towards wider implementation in schools with similar characteristics, while also encouraging digital transformation in vocational learning in Kuantan Singingi Regency.

3.2. Discussion

Overall, this study demonstrates that the developed Google Workspace–integrated PjBL-based e-jobsheet is valid, practical, and effective in supporting LAN network installation learning. Expert validation yielded high Aiken's V coefficients for media (0.836), content (0.809), and language (0.909), practicality testing showed a "very practical" level (85.36%), and effectiveness testing confirmed a statistically significant improvement in student learning outcomes ($p = 0.003$). These findings indicate that the e-jobsheet is both pedagogically sound and operationally feasible for vocational learning contexts.

From a constructivist perspective, these results confirm that learning environments which emphasize authentic tasks, active knowledge construction, collaboration, and reflection—core characteristics of Project-Based Learning (PjBL)—are more effective than conventional, teacher-centered practical instruction. The structure of the e-jobsheet encourages students to engage in problem-solving, planning, execution, and evaluation phases, which aligns with the principles of experiential learning. By embedding project workflows into a digital platform, students were not merely following procedural steps but were actively constructing technical understanding through meaningful tasks, consistent with contemporary constructivist learning theory (Gupta & Pathania, 2020; Ibrahim, 2025; Niyibizi, 2025).

When compared with international TVET research, the findings of this study are consistent with global trends. Studies from Europe, East Asia, and Africa have reported that digitally supported PjBL improves student autonomy, collaboration, and workplace-relevant competencies in vocational education. For example, TVET-focused research has shown that digital project-based environments enhance employability skills and transfer of learning to real industrial contexts. Similar to findings reported in international studies by Akcil et al. (2021), Gupta and Pathania (2020), and Niyibizi (2025), this study demonstrates that cloud-based learning ecosystems facilitate collaboration, provide timely feedback, and strengthen digital literacy, which are increasingly essential competencies in modern vocational education.

Practically, this study shows that integration of Google Workspace tools (Docs, Forms, and Sheets) enables real-time supervision, automatic documentation, and transparent workflow management that are difficult to achieve with traditional paper-based jobsheets. This has direct implications for classroom practice, as teachers can shift their role from administrative supervisors to learning facilitators and mentors. From a policy perspective, the results support national and institutional initiatives for digital transformation in vocational education, suggesting that schools and education authorities should invest in cloud-based learning infrastructures, teacher digital competency development, and sustainable internet access (Inderanata, 2024; Permadi & Huda, 2020; Riani, Thoha, & Hijjah, 2022).

However, the findings of this study should be interpreted with a critical awareness of its limitations. The sample size was relatively small and limited to a single vocational institution, restricting the generalizability of the results. Moreover, the effectiveness evaluation was short-term and primarily focused on cognitive and psychomotor outcomes, while affective outcomes were measured only through perception-based questionnaires. The heavy reliance on stable internet connectivity also represents a structural limitation, particularly for vocational schools located in rural or under-resourced regions, where infrastructure constraints may hinder full implementation (Akmal et al., 2025; Chrismondari et al., 2025; Megayanti et al., 2020).

These limitations point to several directions for future research. Subsequent studies should involve larger and more diverse samples across multiple vocational schools, include longitudinal designs to examine long-term skill retention and employability outcomes, and integrate more robust measures of affective and professional attitudes. In addition, future development should explore hybrid or offline-capable versions of e-jobsheets to ensure accessibility in low-bandwidth environments.

In conclusion, this study contributes empirical evidence that a constructivist-oriented, PjBL-based digital jobsheet integrated with collaborative cloud tools can significantly enhance the quality,

relevance, and sustainability of vocational learning. Beyond its instructional impact, this model offers a scalable framework for aligning technical education with the demands of Industry 4.0 and digital workforce development.

4. CONCLUSION

The findings of this study revealed that the Project-Based E-Jobsheet for Local Area Network (LAN) Installation integrated with Google Workspace is a valid, practical, and effective learning medium for vocational education, specifically in the Computer and Network Engineering program. Validation results indicated high levels of feasibility across media, content, and language aspects (Aiken's V > 0.80), confirming the product's strong instructional and technical quality. The practicality score of 85.36% ("very practical") and a statistically significant improvement in student learning outcomes ($p = 0.003$) demonstrate that the e-jobsheet successfully enhances student engagement, comprehension, and performance in project-based learning environments. The results suggests that PjBL combined with digital environments such as Google Workspace can promote authentic, collaborative and student-centered learning. Such an innovation is consistent with the constructivist learning theory, in which learners are doing and constructing actively what they know through projects that have meaning to them and also involve the world. The e-jobsheet approach to promoting those first NHS principles of critical thinking, problem-solving and team working – essential skills for 21 st century vocational education at a time when practical skills are more valued than ever – is consistent with the refreshed Specification and recognises service-users' access requirements and the investment both can make in equitable digital learning solutions. On a more practical side, our work provides a framework for educators to create interactive, learning media on the cloud that enhance pedagogical quality and effectiveness. However, this study was conducted at a single institution and centered on cognitive and psychomotor learning but assessed affective domain only with balanced affective perception surveys. Furthermore, dependence on internet connectivity could limit use in regions with poor digital infrastructure. Specifically, more widely testing across several vocational schools, including comprehensive affective assessment and longitudinal research are needed alongside developing hybrid or offline versions of this e-jobsheet. This kind of research might reinforce the scalability of the model, as well as make if more widely applicable and conducive to constant innovation in digital vocational learning.

Conflicts of Interest: The authors declare no conflict of interest.

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