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The Influence of PBL on Students' Communication Skills and Thinking Structure in Computer Systems Learning in the TKJ Department of Class 2 of Vocational High Schools

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ABSTRACT

This study aimed to determine the effect of the Problem Based Learning (PBL) model on students' communication skills and thinking structure in Computer Systems learning among eleventh-grade students of the Computer and Network Engineering (TKJ) program. The study employed a Pre-Experimental Design with a One Group Pretest-Posttest Design involving 15 students. The data were analyzed using the Wilcoxon test and N-Gain analysis. The results showed that the mean score increased from 66.80 to 81.33 . The Wilcoxon test yielded a significant value of $0.001 < 0.05$, indicating a significant effect of PBL on students' communication skills and thinking structure. The N-Gain score of 0.3895 was categorized as moderate. Therefore, the PBL model was found to be moderately effective in improving students' communication skills and thinking structure in Computer Systems learning.

Keywords: Problem Based Learning, Communication Skills, Thinking Structure, Computer Systems

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INTRODUCTION

Vocational education is expected to prepare graduates who are technically competent, adaptive, and able to communicate professional reasoning in workplace situations. In the Computer and Network Engineering program (Teknik Komputer dan Jaringan/TKJ), these expectations are especially important because students are trained not only to operate hardware, software, and network devices, but also to diagnose system problems, explain technical procedures, justify decisions, and collaborate with others. The Computer Systems subject is one of the foundations of this competence because it introduces digital logic, processor organization, memory, data representation, and the interaction between hardware and software. However, these topics are often abstract for vocational students because many concepts cannot be observed directly and require students to connect symbolic representations with real technical phenomena. In computer-related education, conceptual understanding is closely related to computational thinking, systematic problem decomposition, pattern recognition, abstraction, and algorithmic reasoning (Wing, 2006; Grover & Pea, 2013; Lye & Koh, 2014). Therefore, learning Computer Systems should not be limited to memorizing definitions, but should also train students to organize their thinking and communicate technical ideas coherently.

In practice, learning in vocational classrooms is still frequently dominated by teacher explanation, note taking, and routine exercises. Such instruction may deliver content efficiently, but it often provides limited space for students to construct meaning, ask questions, defend arguments, or present diagnostic reasoning. Research on active learning shows that student engagement through discussion, problem solving, and meaningful tasks tends to improve learning achievement compared with passive lecture-oriented instruction (Prince, 2004; Freeman et al., 2014). At the same time, studies on guided learning warn that active methods cannot be implemented as unguided discovery; students still need scaffolding, clear problem orientation, feedback, and teacher facilitation, especially when the material is complex (Mayer, 2004; Kirschner et al., 2006; Hmelo-Silver et al., 2007). This issue is relevant to Grade XI TKJ students, who may have technical curiosity but may not yet have a stable structure for explaining why a computer system fails, how data move inside a system, or how a component influences another component.

Two learning outcomes need particular attention in the Computer Systems classroom: communication skills and thinking structure. Communication skills refer to students' ability to express ideas, ask and answer questions, explain procedures, present evidence, and defend solutions in oral or written form. Thinking structure refers to the logical arrangement of ideas when students identify a problem, analyze causes, connect concepts, choose solutions, and draw conclusions. These two abilities are inseparable because students who think systematically are more likely to communicate clearly, while students who are asked to explain and justify their ideas are encouraged to reorganize their understanding. The learning sciences emphasize that interactive learning, explanation, peer discussion, and learning-by-teaching activities can deepen conceptual understanding and strengthen students' ability to articulate reasoning (Chi, 2009; Fiorella & Mayer, 2013; Lou et al., 2001). Cooperative learning research also shows that positive interdependence and group accountability can support achievement and social competence when learning tasks are well structured (Johnson & Johnson, 2009).

Problem Based Learning (PBL) is considered appropriate for addressing these needs because it places authentic problems at the beginning of learning and uses those problems as a context for inquiry, collaboration, and reflection. In PBL, students are confronted with a problem situation, identify what they know and need to know, conduct investigation, discuss possible solutions, present findings, and evaluate the process. This model aligns with constructivist learning because students build understanding through facilitated problem solving rather than merely receiving information (Hmelo-Silver, 2004). PBL also encourages activation of prior knowledge, elaboration, situational interest, and collaborative knowledge construction (Schmidt et al., 2011; Yew & Goh, 2016). Meta-analytic evidence indicates that PBL can have positive effects on students' skills, particularly when assessment emphasizes application, reasoning, and understanding of principles rather than factual recall only (Dochy et al., 2003; Gijbels et al., 2005). Nevertheless, the quality of implementation is crucial because poorly designed problems, weak facilitation, and insufficient guidance may reduce the effectiveness of PBL (Dolmans et al., 2005).

For Computer Systems learning, PBL can be implemented through contextual problems such as diagnosing hardware failure, explaining booting errors, analyzing memory limitations, interpreting digital logic cases, or identifying relationships between processor, storage, and input-output devices. These problems are close to vocational practice and can stimulate students to use technical vocabulary in meaningful situations. With appropriate scaffolding, students can move from fragmented explanations toward more coherent reasoning. Research on computer-based scaffolding in STEM and problem-centered curricula supports the importance of prompts, representations, and guidance for helping learners solve ill-structured problems and integrate higher-order thinking skills (Belland et al., 2017; Kim et al., 2018). In computing education, teachers also face challenges in helping students understand abstract processes, and effective strategies often involve visual representation, discussion, collaboration, and contextual tasks (Sentance & Csizmadia, 2017). These findings suggest that PBL is not simply a method for making learning more active; it is a structured strategy for developing technical reasoning and communication.

Previous studies have widely examined PBL in relation to cognitive achievement, critical thinking, and problem-solving skills. However, research that specifically focuses on communication skills and thinking structure in the Computer Systems subject at the vocational high school level remains limited. Many studies also use experimental and control classes, while classroom-based improvement research in one existing class is still needed to describe how students' abilities develop after a focused intervention. Therefore, this study aims to analyze the effect of the Problem Based Learning model on the communication skills and thinking structure of Grade XI TKJ vocational students in the Computer Systems subject using a one-group pretest-posttest design. The findings are expected to provide practical evidence for vocational teachers who need an instructional strategy that connects abstract computer concepts with real technical problems while also strengthening students' ability to explain, reason, and collaborate professionally. It also supports competency-based learning demanded by contemporary vocational curricula and industry needs.

METHODS

Research Design

Study This use approach quantitative with Pre - Experimental *Design* method . The research design used is *One-Group Pretest-Posttest Design* . In this design this , no There is class control as comparison . Influence treatment assessed with method compare mark before given treatment (*pre-test*) and scores after given treatment (*post-test*) on one same class . Research design can depicted as following :

$$O_1 \; x \; O_2$$

Information :

- O_1*Pre-test* value (before implementation of the PBL model)
- X = Treatment / Treatment (learning using the *Problem Based Learning* model)
- O_2*Post-test* value (after implementation of the PBL model)

Population and Sample

Population in study This is all over student class XI Computer and Network Engineering (TKJ) Department at SMK [State Vocational School 5 MATARAM] in the year 2026/2027 academic year . Retrieval sample done with technique *Saturated Sampling* or *Purposive Sampling* , where 1 class is selected that is currently go through eye lesson System Computers and are considered the most needed improvement ability communication scientific . Selected classes as class experiment single is Class XI TKJ A with amount student as many as 15 people.

Instrument Research and Data Collection

Research data collected through two types instrument the main thing that has been tested validity and reliability :

1. Test Structure Thinking : Using instrument test *essay* - based description solution problem system computer . Test This given moment *pre-test* (O_1) and *post-test* (O_2) for measure to what extent has the change systematics think logical student after treatment .
2. Observation Sheet Ability Communication : Used For evaluate ability communication oral student during the process of implementing the PBL (X) model, especially in syntax presentation results works and discussions group . Indicators assessed covering clarity articulation , accuracy term technical computers , as well as ability argue .

Data Analysis Techniques

For test whether there is influence significant from implementation of PBL in the classroom the data is analyzed in a way statistics with steps following :

1. Prerequisite Test : Conducting normality tests *on pre-test* and *post-test* data using the *Shapiro-Wilk* test (because amount sample < 50 students).
2. Hypothesis Test (Significance Test):
   - If the data is normally distributed , the Paired Sample t-Test is used . know whether There is significant mean difference between before and after treatment .
   - If the data is not normally distributed , non- parametric alternative tests are used namely the Wilcoxon Signed-Rank Test.
3. N-Gain (Normalized Gain) Test: Used For measure effectiveness or size improvement ability communication and structure think student after implementation of PBL with formula :

$$\text{N-Gain} = \frac{\text{Skor Posttest} - \text{Skor Pretest}}{\text{Skor Maksimum} - \text{Skor Pretest}}$$

Criteria N-Gain gain then categorized become high , medium , or low.

RESULT AND DISCUSSION

Research result

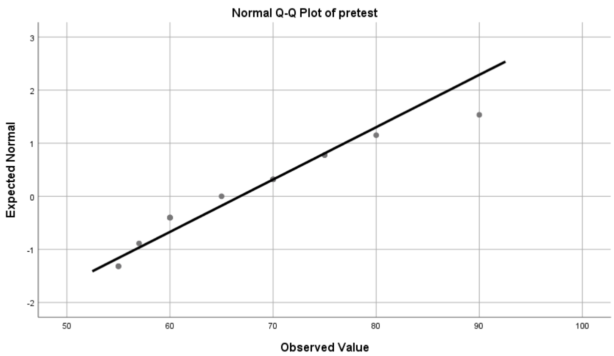
Study This aim For know influence application of the Problem Based Learning (PBL) model to ability communication and structure think student class XI TKJ on the subject lesson System Computer . Research done against 15 students with use design One Group Pretest-Posttest Design .

1. Analysis Descriptive Data

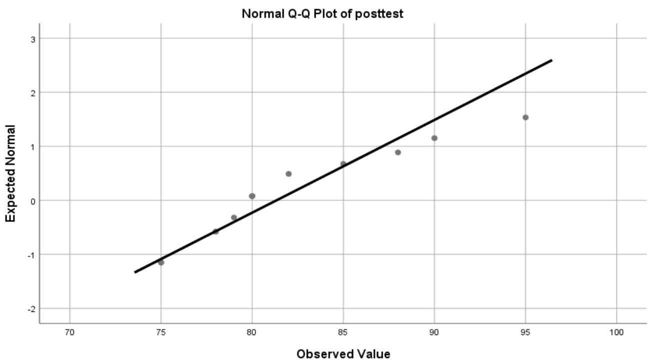
Analysis results descriptive show existence improvement mark student after The Problem Based Learning (PBL) model was applied . Statistical data descriptive can seen in Table 1.

Table 1. Statistics Descriptive Pre-test and Post-test

Variabel	N	Mean	Standard Deviation	Minimum	Maximum
Pre-test	15	66.80	10,143	55	90
Post-test	15	81.33	5,827	75	95



Pretest diagram



Posttest diagram

Based on Table 1, the average pre-test score of students as big as 66.80 , while the average post-test score increased become 81.33 . Happened improvement as big as 14.53 points after implementation of the PBL model. In addition , the standards deviation in the post-test is greater small compared to the pre-test, namely from 10,143 to 5,827. This is show that after learning using PBL, ability student become more evenly.

2. Normality Test

Normality test done using the Shapiro-Wilk test Because amount sample not enough of 50 students .

Table 2. Results of the Shapiro-Wilk Normality Test

Data	Sig
Pre-test	0.151
Pre-test	0046

Criteria taking decision :

- If the Sig. value > 0.05 then the data is normally distributed

- If the Sig. value < 0.05 then the data is not normally distributed

Based on normality test results, the pre-test significance of 0.151 > 0.05 , so the pre-test data is normally distributed. However, the value post-test significance of 0.046 < 0.05, so the post-test data is not normally distributed. Therefore, testing hypopost-test significance valuethesis using non- parametric tests Wilcoxon Signed-Rank Test

3. Hypothesis Testing Using the Wilcoxon Signed-Rank Test

The results of the Wilcoxon test show the data as following.

Table 3. Results of the Wilcoxon Signed-Rank Test

Statistics	Mark
Z	-3,185
Asymp . Sig. (2-tailed)	0.00

Criteria taking decision :

- If Sig. < 0.05 then H_0 is rejected and H_1 is accepted .
- If Sig. > 0.05 then H_0 is accepted and H_1 is rejected .

Significance value obtained is 0.001, more small from 0.05. With Thus, H_0 is rejected and

H_1 is accepted, which means there is significant influence from application of the Problem Based Learning (PBL) model to ability communication and structure think students in the eye lesson System Computer.

The Wilcoxon rank test results show that there is 13 students experience improvement value**,** whereas 2 students own fixed value, and not there is students who experience decline value. Findings This indicates that part big student get benefit positive from application of the PBL model.

4. N-Gain Analysis

N-Gain analysis is used For know level effectiveness application of the PBL model to improvement ability student.

Table 4. N-Gain Calculation Results

Variables	Mean	Category
N-Gain Score	0.3895	Currently
N-Gain Percent	38.95%	Currently

Based on results calculation, the average N-Gain Score obtained was 0.3895 or 38.95%. This value including in category moderate. This is show that the application of the Problem Based Learning model is sufficient effective in increase ability communication and structure think student.

CONCLUSION

The results of this study indicate that the implementation of the Problem Based Learning (PBL) model has a positive effect on the communication skills and thinking structure of Grade XI TKJ students in the Computer Systems subject. This can be seen from the increase in students' average scores, from 66.80 in the pre-test to 81.33 in the post-test. This improvement occurred because the PBL model provides students with opportunities to learn actively through solving real problems related to Computer Systems material. In the learning process, students do not merely receive information from the teacher, but are also involved in group discussions, problem identification, information gathering, and the presentation of solutions. These activities encourage students to develop their communication skills while also building a more systematic and logical thinking structure.

The results of the Wilcoxon test show a significance value of 0.001, which is lower than 0.05. This finding proves that the improvement was not accidental, but rather the result of implementing the Problem Based Learning model. In other words, the PBL model has been proven effective in helping students understand Computer Systems concepts that were previously considered difficult and abstract. This finding is in line with the theory proposed by Arends (2012), which states that Problem Based Learning can improve higher-order thinking skills because students are required to analyze problems, formulate solutions, and communicate their findings to others. In addition, Duch (1995) explains that problem-based learning can improve communication, collaboration, and problem-solving skills because students learn in situations that resemble real-world conditions.

The N-Gain analysis result of 0.3895, which falls into the moderate category, shows that although the improvement has not yet reached a high category, the implementation of PBL still provides a meaningful contribution to the development of students' abilities. This moderate category may be influenced by several factors, such as limited learning time, students' relatively new experience with problem-based learning, and the diversity of students' initial abilities. In addition to improving learning outcomes, the application of PBL also shows a positive impact on students' communication skills. During the learning process, students became more active in expressing opinions, explaining ideas, and defending arguments based on facts obtained from discussions and investigations. This condition shows that the PBL model does not only improve cognitive aspects, but also develops 21st-century skills that are highly needed in the workplace, especially in the field of Computer and Network Engineering.

Overall, the results of this study prove that the implementation of Problem Based Learning can create a more active, collaborative, and meaningful learning process. Therefore, the PBL model can be used as an alternative learning strategy in the Computer Systems subject to improve the communication skills and thinking structure of vocational high school students, particularly those in the Computer and Network Engineering Department.

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