



Development of Learning Media Practicum Air Conditioning System Based on Problem Solving in Vocational Education

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Abstract. Learning media acts as a tool to convey knowledge and skills from teachers to students. This study aims to: (1) develop problem solving-based learning media; (2) revealing the feasibility of the problem solving-based air-cooling system practicum learning media that was developed to be applied; (3) revealing the effectiveness of practical learning media based on problem solving of the air conditioner system. This research is learning media development research that refers to the ADDIE development procedure by the branch. The stages in this research include: (1) analysis, (2) design, (3) development, (4) implementation, and (5) evaluation. The subjects of this research trial were limited to 7 students, and the broad trial was 18 students. Collecting power in this study using observations, interviews, documentation, and measurements. The results of this study are as follows: (1) the learning media developed consists of a set of practicum test equipment units equipped with an analysis table for the diagnosis of damage to the air conditioner system. (2) the results of the feasibility assessment by learning media experts are included in the very feasible category with a percentage result of 94.3%; (3) the results of the effectiveness test show that the problem solving-based learning media developed is effective as seen from the results of student practicum.

Keywords: digital competencies · students · vocational schools

1 Introduction

Vocational education aims to produce graduates who have skills according to the needs of the world of work. The development of the industrial revolution 4.0 currently requires workers who have high thinking skills [1] So that the vocational education learning process must adapt and train students to think at a higher level. Workers are required not only to be able to apply skills and knowledge, but also to be able to analyse, evaluate, and even be able to be creative [2]. High-level thinking skills are produced through the learning process by making students the centre of learning.

The learning process managed by the teacher must make students the centre of learning, so that the role of students is more dominant in learning and the teacher is

a facilitator. However, in practical learning, to make students the centre of learning, it must be supported by interactive learning media. The use of interactive learning media can make the learning atmosphere more varied and can facilitate students to learn independently [3]. Learning media has a role as a tool to convey knowledge and skills [4, 5]. Teacher and student communication can occur actively in the learning process if it is supported by interactive learning media [6]. The teacher's role in the learning process using interactive learning media can facilitate student-centered learning [7]. Practical learning aims to improve students' skills as well as students' knowledge. Increasing students' knowledge and skills can be improved if they are supported by practicum learning media that are able to hone students' thinking skills.

Higher order thinking skills (HOTS) are one of the student abilities that must be developed [8]. Challenges and technological developments in various aspects are challenges that must be faced by anyone. Practicing higher order thinking according to Bloom's taxonomy has three levels, namely analysis, evaluation, and creation. The ability to analyse and evaluate and create can be packaged into learning models and learning media. Improving students' higher order thinking skills is the main goal of the current learning process [9].

The problem of learning media currently used by vocational students does not yet have the characteristics of problem solving-based learning media as a form of modelling for suitability with working conditions when later working in industry. Problem-solving is a strategic competency shown by students in understanding, choosing approaches and problem-solving strategies, and solving models to solve problems [10]. Nowadays, problem solving skills are needed in the world of work [11]. Problem solving skills as the ability define the problem, determine the cause of the problem, determine priorities, select various options solutions, and implement those solutions [12]. Therefore, it is necessary to develop learning media based on problem solving in practical learning to be able to improve students' higher-order thinking skills. Students must be trained to express their arguments and thinking skills [13].

2 Method

The research and development model used is the ADDIE model. Namely (1) analysis, (2) design, (3) development, (4) implementation, (5) evaluation. The analysis phase includes an analysis of the needs of learning media development, the planning phase includes planning the design of the learning media framework, the layout design of the instructional media installation, and the design of problem-solving flow diagrams, the development phase includes the manufacture of learning media devices for the air conditioning system and the creation of tables in the form of problem-solving analysis diagrams. in the air conditioning system, the implementation phase is carried out by conducting field tests, product assessments, and product revisions, and at the evaluation phase includes validation evaluations by experts, and assessments by students. The subjects involved in this study were 20 students about air conditioning systems which were divided into 4 practical study groups.

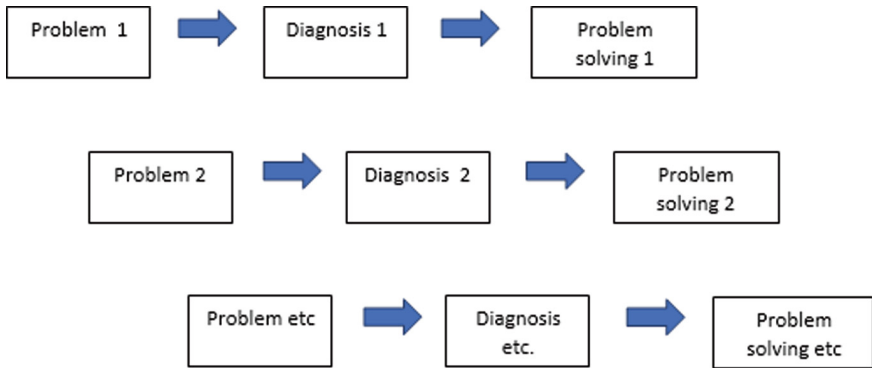


Fig. 1. The concept of problem solving analysis table

3 Results and Discussion

3.1 Analysis

The analysis phase is carried out by analysing the information obtained through observation to determine the need for learning media development. Data information is obtained through direct data collection in the field and literature study. Based on the results of field observations and literature studies, the results are (1) a lack of air conditioning system practicum learning media, (2) available air conditioning learning media are not equipped with problem analysis tables, (3) students have difficulty doing independent practicum.

3.2 Design

The next step is the design phase of the problem-solving-based air conditioning system learning media. The first step is to compile a table of damage to the air conditioning system. The table is arranged sequentially based on the order of the damage diagnosis. Based on the damage table and analysis of the diagnosis of the damage, the next step is to formulate ways to solve problems that occur in the air conditioning system. Figure 1 is a problem-solving concept in problem-solving-based learning media.

3.3 Development

The next stage is the product development stage. Product manufacture includes the preparation of materials and tools, manufacture of instrument panels, installation of air conditioning systems, and installation of problem-solving analysis diagram tables. After the prototype is made, it is then validated by experts. Figure 2 is the result of developing a prototype of problem-solving based air conditioning system practicum learning media.

The learning media developed has panels that can be used by teachers to provide treatment in the form of problems that generally occur in air conditioning systems. Panel positions for troubleshooting are on each air conditioning component. The purpose of



Fig. 2. Prototype of problem-solving based air conditioning system practicum learning media

Table 1. Validity test results by learning media experts

Aspect	Maximum score	Score obtained	Percentage	Information
Appearance	28	26	92.86	Very Feasible
Navigation	5	4.5	90.00	Very Feasible
Usage instructions	4	4	100	Very Feasible
	Average		94.3	Very Feasible

adding a panel of problems is to make it easier for teachers to give tests to students and provide students with needs to hone the analysis of improving the air conditioning system. The following are the results of validation by practicum learning media experts which are shown in Table.

It can be understood that from Table 1, according to instructional media experts, the assessment of instructional media is feasible from the aspect of appearance, with a percentage of 92,86%, and feasible from the navigation aspect, with a percentage of 90%, and from the aspect of utilization instructions it is categorized as very feasible with a percentage 100%. The average expert validation of the model is categorized as feasible, with a percentage of 94,3%.

4 Implementation

The implementation phase is carried out through pre-test and post-test trials which aim to determine the level of students' ability to diagnose damage to the air conditioning system before and after using the developed learning media. Figure 3 is the results of testing the use of problem solving-based learning media.

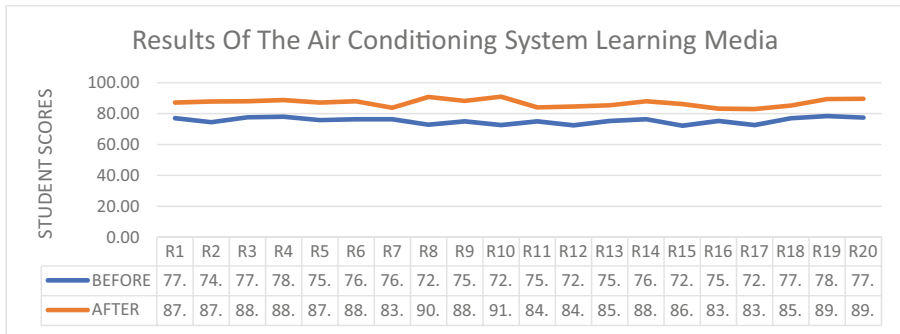


Fig. 3. Graph of learning outcomes of air conditioning system practicum before and after using problem solving-based learning media

Table 2. Test the normality of the data

Normal Parameters ^{a,b}	Mean	86.9700
	Std. Deviation	2.44112
Most Extreme Differences	Absolute	.138
Test Statistic		.138
Asymp. Sig. (2-tailed)		.200 ^{c,d}

Based on the analysis of the results of practicum learning before and after the use of learning media, it shows an increase in learning outcomes which include the ability to analyse problems and overcome problems that occur in the air conditioning system. These results indicate that by using problem solving-based learning media, students have a better ability to analyse problems in the air conditioning system when compared to similar learning media that are only used in practicum in accordance with standard operating procedures (SOPs) in the practicum manual. Problem solving learning provides critical thinking skills [14, 15]. Critical thinking is an important competency that must be possessed by students. The challenges of a competitive world require critical thinking to enable students to have the ability to analyze problems in their work [16]. Critical thinking is part of higher order thinking skills, and it is needed in the digital era [17].

The results of the analysis of the normality test in Table 2 show that the results of the practical study of the air conditioning system have a mean value of 86.9700 and a standard deviation of 2.44112. The absolute value of D is 1.38 with the z-value of Kolmogorov-Smirnov 0.700. This z value gives a probability value of 0.711.

which is far above the alpha value = 0.05. So it can be concluded that we cannot reject the null hypothesis which states that the daily sales data is normally distributed. Next is hypothesis testing, the results of which are shown in Table 3.

The Table 3 shows that the variable value of the results of the practice of the air conditioning system t-count 159,329 and Table 2 093024 with a significance of 0.000, H_a which reads that the value of the practice of the problem solving-based air conditioning

Table 3. Hypothesis test results

variable	t-count	t-table	sig	T-test result
Air conditioning system practical value	159.329	2.093024	0.000	Because t count > t-table and significance < 0.05, then h_a is accepted.

system is more than 75 acceptable. This shows that the value of practical learning outcomes using problem solving-based learning media is higher than the minimum value that has been determined. Research on problem solving-based learning media has also been carried out and the result is that students find the learning media very interesting [18]. Student interest in the learning process is needed for good student learning outcomes. Because interesting learning media increase students' learning motivation [19]. Thus, this research finds new facts that problem-solving-based learning is not only through its strategies and methods but learning media must also support learning strategies and methods. Because learning must be integrated [20].

5 Conclusion

Based on the ADDIE model the development of problem solving-based learning media is carried out in five stages, namely analysis, design, development, implementation, and evaluation. The learning media developed consisted of learning media for the air conditioning system and a flow chart table for analyzing problems that occur in the air conditioning system and how to solve problems that arise. The results of the feasibility assessment of learning media developed by learning media experts obtained a very feasible category with a percentage of 94.3%.

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