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Student's Problem-Solving Skills in Thermodynamics at Dampelas 1 Senior High School

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Abstract

This study explores students' problem-solving skills in thermodynamics at Grade XI Science Senior High School 1 Dampelas. This research is a qualitative descriptive study. The research subjects consisted of 6 students was conducted in a high school in Dampelas. The research instrument used was a test of student's problem-solving skills on thermodynamic based on Polya's problem-solving. Respondents consist of various cognitive abilities (high, medium, and low). They were also willing to do an interview. This study indicated that students' problem-solving skills on thermodynamic materials based on Polya's problem-solving steps in the "problem understanding stage" indicator are in the moderate category. Similarly, the "planning stage" indicator is categorized in the moderate category, whereas the "implementation stage" indicator. The "revisiting stage" falls into the moderate medium category with an average percentage of 66.66 %. This research implies that it is hoped that the teacher can use the Polya stages in giving practice questions or homework to students to solve physics problems.

Keywords: Problem Solving Skills; Thermodynamics

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INTRODUCTION

As a long-term investment for the future, education equips students to adapt to today's changes. Through education, it is hoped that students can achieve success in the future. Several factors cause students who have not succeeded. Among them are students' learning methods that are not appropriate, the selection of teacher learning strategies that are not following the characteristics of students, less supportive facilities, and others (Pingge & Wangid, 2016; Simbolon, 2014). As a result, there needs to be an evaluation activity to measure that success (Mahirah, 2017).

There are several obstacles experienced by students in the learning process, such as students having difficulty solving problems, especially in physics lessons (Samudra, Suastra, & Suma, 2014; Wijayanti & Hindarto, 2012). This subject always presents problems that require students to think critically and systematically to solve these problems (Misbah, Mahtari, Wati, & Harto, 2018; Supriyono, 2014; Yuberti et al., 2019).

Problem-solving skills are the main competencies needed in today's era. When students are skilled at solving problems, students will get used to solving problems in everyday life independently (Hendriani, Melindawati, & Mardicko, 2021; Sumartini, 2016; Thersia, Arifuddin, & Misbah, 2019). In addition, students will be able to understand complex issues that occur in various aspects of life.

Problem-solving skills can be trained through assignments given to students. So in the learning process, doing exercises or assignments is very important. The more students work on a question or exercise, the more concepts they tend to understand (Hasibuan, 2015; Sopia, Sugiatno, & Hartoyo, 2019). However, students' enthusiasm for doing the exercise or task may differ (Djarod, Wiyono, & Supurwoko, 2015).

In solving physics problems, students more often directly use mathematical equations without analyzing, guessing the formulas used and memorizing examples of questions that have been worked on to work on other problems. Students have difficulty when dealing with complex problems. Students can solve simple quantitative problems but cannot solve more complex problems (Amiruddin, 2018).

Based on the results of observations carried out by the researcher at Senior High School 1 Dampelas, each student has different ways of solving the exercise questions. Some students can complete the practise questions faster, but some students solve the practice questions slightly slower. Therefore, to analyze students' problem-solving skills in thermodynamics, this research was conducted.

METHOD

This study uses a qualitative descriptive method by analyzing student's problem-solving skills on the material of thermodynamics. The research was conducted at Senior High School 1 Dampelas, Dampelas District, Donggala Regency, Central Sulawesi Province. The subjects in this study were six students of class XI I Science who had different cognitive abilities.

Data on students' problem-solving skills were obtained through essay tests. Then the solution is analyzed using the Polya problem-solving step. The number of question items is six items. The categories of students' cognitive abilities are listed in Table 1.

Table 1 The Cognitive Abilities Category

Percentage Score	Criteria
81 % - 100%	Very good
61 % - 80 %	Good
41 % - 60 %	Moderate
21 % - 40 %	Poor

The researcher then grouped the students based on their cognitive abilities into 3 categories: low, medium, and high. The results can be seen in Table 2.

Table 2 Respondent Category

Respondent	Score	Category
R–02	88.33%	Highest
R–03	75.00%	Medium
R-05	11.66%	Lowest

Based on the categories mentioned in Table 2, students in each category of a high, medium, and low will be interviewed by considering the answers. Respondents (R2) are respondents who are at the highest score level, respondents (R3) are categorized in the medium score level, and respondents (R5) get the lowest score level.

RESULT AND DISCUSSION

One of the strategies used is to train students' problem-solving skills, according to Polya. Polya (1973) has four stages of completion, namely understanding problems, plan solutions, carry out the plan, and looking back. Understanding the problem is identifying what problems are required to be solved and the facts to be used. The next stage is to create and execute the designed plan.

Then, the activities are re-examined regarding the correctness/certainty of the solution.

Understanding the Problem

High-Level Respondents

Respondents with high-level skills were able to write down the information on the questions. This can be seen when the respondent has correctly written down what is known and asked. Following are the results of the respondent's answer, writing down what was known and asked. Results of high-level respondents' answers can be seen in Figure 1.

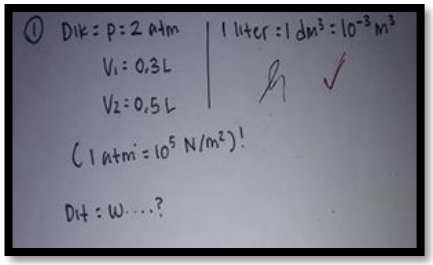

Figure 1 Results of High-Level Respondents' Answers

Based on Figure 1, the respondents already understand what information is known and what is being asked.

Medium Level Respondents

Medium-level respondents can write down the information on the questions. This can be seen when respondents write down what they know and ask. Following are the results of the respondent's answer, writing down what was known and asked.

Medium level respondents' answers can be seen in Figure 2.

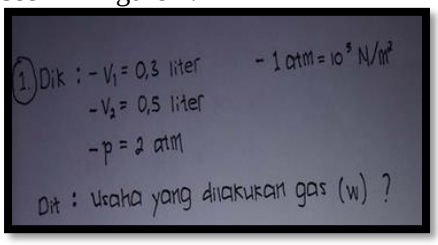

Figure 2 Medium Level Respondents' Answers

Based on Figure 2, the respondents already understand what information is known and what is being asked.

Low-level respondents

Low-level respondents were able to write information on the questions. This can be seen when the respondent has correctly written down what is known and asked. The following are the answers of low-level respondents who write down what is known and asked. The results of low-level respondents' answers can be seen in Figure 3.

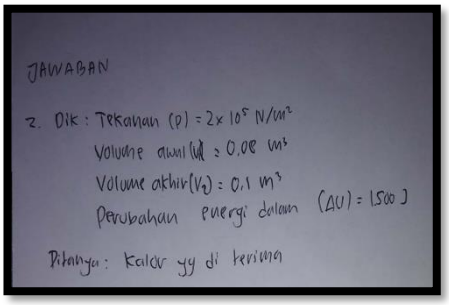

Figure 3 Results of Low-Level Respondents' Answers

Plan Solutions

High-Level Respondents

In solving problems, high-level respondents read each sentence and try to understand the meaning of the problem. After high-level respondents already understand what information is known and what is being asked. High-level respondents began planning initial steps to solve existing problems. The following interview results prove this.

Researcher:

R-02, what is your strategy/way to solve this problem?

Respondent:

The solution to this problem is the formula P (ΔV) = P ($V_2 – V_1$). From there the second formula is used, namely W = P (V_2-V_1) where P is 2 atm x 10^5 N / m2 (0.5 L - 0.2 L) x $10^{-3}m^3$ = 60 J.

Based on the results of the interview above, it shows that high-level respondents have already made plans

before working on them. Respondents also determine what is known and what is asked in solving the questions.

Medium Level Respondents

In solving the problem, the respondent reads the questions from each sentence and tries to understand the meaning of the questions. Medium-level respondents read the questions twice. After the respondent understands what information is known and what is being asked about, the respondent starts planning initial steps to solve the existing problem. The following interview results prove this.

Researcher:
The next question, what is the strategy or method of R - 03 in solving these problems?
Respondent:
After that to solve this problem we use the formula $Q = W + \Delta U$. To find $W = P (V_2-V_1)$. So, $Q = P (V_2-V_1) + \Delta U$. The pressure is $2x10^5$ N / m^3 ($0.1 m^3$-$0.08m^3$) + 1,500 J = $0.04x10^5$ J + 1,500 J = 4,000 J + 1,500 J = 5,500 J

Based on the interview results above, it shows that the respondent has made a plan before working on it. However, the respondents read the questions in a low voice. This is because the respondent still experiences confusion in understanding the meaning of the questions.

Low-Level Respondents

In solving the problem, the respondent reads the questions from each sentence and tries to understand the meaning of the questions. Respondents read each sentence of the questions twice. Respondents experienced difficulty when reading the questions once, and this was repeated. The following interview results prove this.

Researcher:
Try to explain in your own words what the problem meant number two?
Respondent:
Here (while reading the question), number two, the statement is 8 moles of Ideal gas heated at a constant pressure of $2x10^5$ N / m^2 so that its volume changes from 0.08 m^3 to 0.1 m^3. If the gas undergoes a change in energy in the gas of 1,500 J, how much heat does the gas receive?
Researcher:
Try to explain from the questions what is known and what was asked?
Respondent:
Well, here we know the pressure or P = $2x10^5$ N / m^2, the initial volume or V_1 = 0.08 m^3, the final volume or V_2 = 0.1 m^3, the change in energy or 1.5U = 1,500 J. while the one asked for the heat received?

Based on the interview results above, it shows that the respondent did not make an initial plan before working on the questions. Respondents did not specify what steps to take when solving the questions. This is because the respondent had difficulty reading once, and this had to be repeated.

Carry out the Plan

High-Level Respondents

The first thing the respondent did was to read the existing questions. At this stage, the respondent tries to understand the problem by writing what is understood from the given problem. Respondents write on the answer sheets given what is known and what is asked of the questions. After writing down what was known and what was asked from the questions, the respondent then began to implement the plan that had been previously planned. Respondents perform calculations to find solutions to the questions given and answer questions.

Medium Level Respondents

Respondents read the questions twice, and the respondents read the questions in a low voice. This is because the

respondent is confused, the respondent reads for the second time, and after understanding the questions, the respondent writes in the answer sheet what is known and what is being asked from the questions. The respondent then starts to carry out the plan that was previously planned. Respondents perform calculations to get solutions to the questions given and answer questions.

Low-Level Respondents

Respondents read each sentence of the question twice. Respondents had difficulty reading one question, and this had to be repeated. Respondents write in the answer sheets given what is known and what is asked. The respondent then writes the steps to complete without any planning. From the results of interviews with respondents, respondents experienced confusion in answering the questions given.

Looking Back

The last stage is the stage of checking again. At this stage, an indication of reaching the rechecking stage is that the respondent checks the answers that have been given. Based on the interviews conducted with the three respondents, they reviewed the steps they took in solving the questions before giving the answer sheet to the researcher.

Based on the first indicator, namely understanding the problem, respondents of high-level abilities could understand the problem by only reading the questions given once. The second indicator, which was planning the solution, had already made a plan before working on the questions. They first determined what was known and what was being asked from the questions. The third indicator, which was implementing the plan, respondents of the high-level ability had also determined what steps should be taken to solve the questions given. At the last indicator, which the solutions, the respondents rechecked the steps taken in solving the questions. For those with medium-level abilities, the first indicator was to comprehend the problems being solved, and the respondents understood the problems when they read the question items twice. The second indicator the respondents had already made plans for doing the exercises. In the third indicator, which was carrying out the plan, the respondents were unable to determine the steps that must be done to solve the problems given. The respondents claimed that it was confusing and complicated to understand the meaning of the question items. As for the last indicator, which evaluated and reviewed the steps done, the respondents fulfilled this indicator well.

The first indicator understands the problems given, and those with low low-level abilities managed to comprehend the problems by reading the questions twice. The second indicator refers to designing the plan, and unlike the high-level and medium-level respondents, the low-level abilities did not make any initial plans before working on the questions. Even though the respondents could write down what was known and what was asked, the respondent still did not understand what information was implied. The third indicator, which was implementing the plans, respondent planning, did not determine what plans should be done and what steps must be taken to solve the questions given. In the fourth indicator, which was reviewing or evaluating, the respondents did this step just fine. This is due to the lack of students in practising questions with a high level of difficulty and a lack of understanding of physics concepts (Alfika & Mayasari, 2018; Purwito, Huriawati, & Purwandari, 2019).

Based on the results of relevant research, the researcher suggests several things, including problem solving is one of the core and art of learning Physics, it

is necessary to familiarize students with giving questions related to problem solving with Polya stages because by getting used to this students will think more critically and systematically, The questions and problems given to students should be varied from simple to complex questions, problem-solving analysis for students should be carried out routinely, this will be a benchmark for further learning (Alfika, 2018; Hafizah, Misbah, & Annur, 2018).

Based on the results of the following relevant research, it is the factors that cause the errors made by students at stage (1) understanding the problem is that students are not careful in reading the questions and students are not used to writing what is known and what is asked in the questions. (2) preparing a plan is that students are not used to writing the plans used, such as writing down the steps for completion and formulas. (3) implementing the plan are students who do not solve the questions given according to the plan that has been prepared, students are not careful in making calculations, and students are not careful in making conclusions about the problems given. (4) rechecking is the student made a mistake in doing calculations when checking again and did not get the correct final result. In addition, students are not accustomed to rechecking the solutions they get because they feel confident with the answers (Agustina, Yani, & Herman, 2019; Azizah, Yuliati, & Latifah, 2015; Pratama, Suyudi, Sakdiyah, & Bahar, 2017).

CONCLUSIONS

The student's problem-solving skills in thermodynamic according to Polya's problem-solving steps on the "problem understanding stage" indicator were in the moderate category, and similarly, the "planning stage" indicator was included in the moderate category. On the other hand, in the poor category and the "review stage" are moderate. This research implies that it is hoped that the teacher can use the Polya stages in giving practice questions or homework to students so that students can be trained and easily understand the questions given.

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