Thermodynamics Learning Based On Collaborative Problem Solving (Collaps) To Improve Prospective Physic Teachers' Problem Solving Ability

Arini Rosa Sinensis, Harry Firman, Ida Hamidah, Muslim

Abstract: The purpose of this study is to find out the improvement of prospective physic teachers' thermodynamic Problem Solving Ability through the application of CollaPs (Collaborative Problem Solving) learning models assisted by Interactive Simulation and Derivative Games. The method used in the study is quasi-experimental design with pre-test and post-test control group. The sample consisted of 23 prospective physic teachers in the experimental group and 18 prospective physic teachers in control group. Data collection techniques of the study using the test solving instrument problems which consist of four aspects; 1) Problem Schema, 2) Analogy, 3) Causal and 4) argumentation. The results showed that the problem solving N-Gain value of Experimental group had a higher average than the control group. Therefore it is concluded that the implementation of CollaPs model assisted by interactive simulations and derivatives games can improve the ability of prospective physic teachers in thermodynamic Problem Solving.

Index Terms: Collaborative Problem Solving, Problem solving, Thermodynamic

1 INTRODUCTION

Thermodynamics is one of the important subjects to be understood by a prospective physics teacher. Thermodynamics is the most important fundamentals in modern science and technology [1]. The thermodynamic topic studies the physics of energy, related to heat, temperature change, work, processes, and entropy. Various applications in thermodynamics are easy to find in daily life, but there are still difficulties in learning the concept of thermodynamics. Those Abstract concepts, studying cycles and processes, thorough mathematical understanding caused thermodynamics learning increasingly perceived as an unattractive subject. Nowadays there have been methods developed to produce effective learning [2]. Kind of learning that assigned students to compile knowledge independently based on their background, perception and social environment. Involving students' activity in learning. Collaborative Problem Solving (CollaPs) learning method contains important skills to be developed [3]. Specific related skills consist of four components for higher education: Leadership, teamwork, communication and, problem-solving [4]. Lesson learned in the model trains physic students' problem-solving skills, which involves communication activities, argumentation, joint problem solving and reflection. Collaborative problem solving is a responsive problem approach activity by cooperative working and exchanging ideas [5]. The activities are also very useful in time of handling complex problems. In collaborative learning, students work together in their activities to find solutions to specific tasks or problems.

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The activities carried out are interrelated, building on one another therefore social skills emerge in this activity. This learning is very important to be applied in the education of prospective teachers [6]. Problem-solving is an important topic in physics education and is closely related to cognitive processes and creativity [7]. Problem -solving is a process, which involves systematic observation and critical thinking to find solutions or appropriate ways to achieve the desired goals [8]. Therefore the problem -solving process in CollaPs learning activities supports to hone students' problem-solving skills in learning Thermodynamics. As it is known, learning thermodynamics is not only about content domination but also the ability to solve problems is important to master. This is because there are essential concepts and difficult concepts learned in thermodynamics [9,10]. Cycle analysis understanding, graphs and, thermodynamic processes forge students to be able to analyze several thermodynamic applications encountered in daily life. It is also provides students' experience in gathering information and solving problems. Through CollaPs learning, students jointly contribute thought, ideas and opinions in solving problems. Hence the finding of difficult thermodynamics will turn into easy thermodynamics due to finding solutions with collaboration.

2. RESEARCH METHODS

The method used in this research is quasi-experimental with pre-test and post-test control group design. The experimental group consisted of 23 students and the control group consisted of 18 students of the thermodynamics class. In the experimental group, learning was applied to the CollaPs model meanwhile in the control group with conventional learning. The study was conducted as many as 5 meetings under the topic of heat energy, the first law of thermodynamics, and the second law of thermodynamics, heat engine and entropy. Data collection techniques using thermodynamic problem-solving test instruments consisting of 16 test questions. Measured solving abilities aspects include Problem Schema, Analogy, Causal and, Argumentation. The data analysis technique uses N-Gain to discover the improvement of problem-solving abilities for each aspect. The procedure of conducting research is shown in the following Figure 1

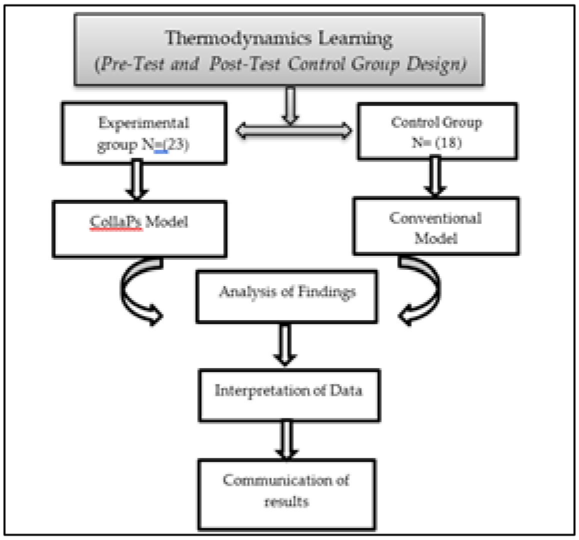

Figure 1. *The procedure of conducting research*

3. RESULT AND DISCUSSION

The improvements of problem-solving abilities were analyzed using N-Gain as used by [11]. The increasing impact of problem- solving abilities in the control and experimental groups. The N-Gain average results of problem-solving abilities in the control and experimental groups are shown in Table 1.

Table 1. *The N-Gain a Results of Problem-Solving Abilities*

Aspect	Group	N	N-Gain	Interpretation
Total	Experiment	23	0.685	Medium
	Control	18	0.479	Medium
Problem Schema	Experiment	23	0.642	Medium
	Control	18	0.421	Medium
Analogi	Experiment	23	0.735	High
	Control	18	0.519	Medium
Causal	Experiment	23	0.764	High
	Control	18	0.548	Medium
Argumen	Experiment	23	0.712	High
	Control	18	0.534	Medium

According to Table 1, it can be concluded that the thermodynamics lecture program with the CollaPs model has a positive influence on improving the ability of thermodynamic solving problems. This thing was revealed based on the higher N-Gain average of group experiment than the control group. The N-Gain comparison between those two groups (Control and Experiment group) can be seen in Figure 2.

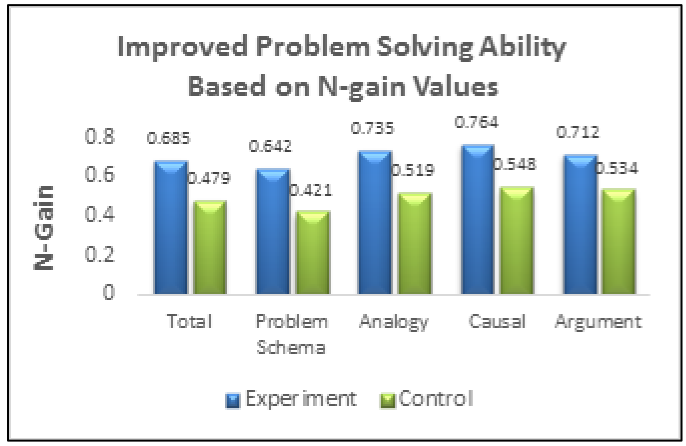

Figure 2. *Comparison of N-Gain experimental and control group problem solving abilities*

The comparison diagram of the N-Gain values in Figure 2, shows that the total N-Gain in the experimental group is higher than the control group, as well as in each aspect of problem-solving. This is because CollaPs-based Thermodynamic learning as an effort to improve problem-solving skills is designed to equip problem-solving abilities through several stages consisting of 1) Building Readiness, 2) Problem exploration, 3) Joint Problem Solving, 4) Reflection and 5) Evaluation Process and Results. CollaPs model in thermodynamic learning assisted by interactive simulation media aims to assist students in understanding abstract concepts, graph representation [12], thermodynamic cycles and thermodynamic processes [13]. Simulations promote student involvement in exploration [14] and thermodynamic understanding [12]. Derivative Games are designed as mathematical games to improve the understanding of thermodynamic mathematics. By using games to create meaningful learning, students can be active [15], work together to be involved in problem-solving activities, think logically and become reflective and independent learners [16]. Based on the results of implementation and analysis, it can be noticed that all aspects of problem-solving ability have successfully improved. The improvement of problem-solving scheme ability through learning CollaPs is better than the control group, however, if it is compared to the N-Gain value in other aspects, the problem scheme has a lower N-Gain value. This is not a complex problem, the effect of lower N-Gain value indicates that students are not able to present thermodynamics problem maximally, especially those in mathematical problems scheme. Based on the results of research [17] the importance of understanding structured problems optimally will result in solving complex mathematical problems. In fact, this ability is also trained at the stage of problem exploration and problem-solving together in learning. As an improvement, students are trained and accustomed to learning to categorize problems in the type of problem (i.e., schemes based on mathematical structures) on thermodynamics, implement efficient solution strategies for each problem schema, and understand the meaning of the problem [18]. The analytical ability of N-Gain value in the experimental group was higher than in the control group. The ability of analogy is intended therefore students can explain abstract concepts [19] to help students understand abstract concepts [20]. Through learning CollaPs assisted by interactive simulations, helps students to understand abstract concepts of thermodynamics, especially on the concepts of heat energy and heat engines. Besides that, trough the task of solving problems, gathering information, problem analysis can train students in understanding and mapping information from certain subjects to another subject. According to [19] based on the results of interviews with teachers related to things needed in analogy thinking in problem-solving, namely: 1) Organizing tasks, 2) Practicing procedural and transfer skills, 3) Understanding of basic concepts in accordance with the theme or learning objectives. besides, according to [20] analogy analysis makes students more active therefore the effectiveness of learning increases. Causal ability in solving problems was found with the highest average N-Gain value. This is because Causal thinking is one of the most fundamental and important cognitive processes that support high-level activity in problem-solving [21]. Another reason is that students can relate cause problems and associate causal in daily life. The activity can be seen at the problem discussion stage, through the stage, a student doing problem identification, discovering sources of information based on their experiences and applications of daily life that are easily found therefore it facilitates students in finding Causal relationships. Qualitative representations of concepts also illustrate the basic relationships that explain the causal relationships of the variables involved in the concept [22]. CollaPs learning also improves the ability of argumentation; the same results are explained as in research [23] and collaborative learning also has a significant influence on argumentation [24]. The importance of scientific argumentation as a learning goal in science education is also an effective learning approach for constructivist science learning [25]. In learning argumentation is also trained in the activity of reflection, i.e. students provide arguments for the findings presented by other teams and compare with their findings. In the argumentation activities, students reflect or describe their assessment[26]. Several studies on CollaPS learning showed a high cognitive achievement from social knowledge construction (for example, approval or use of newly constructed meaning) contributes to successful team projects [27]. The researchers also examined a significant collaborative system in the problem-solving process[28]. In addition, interactive simulation media assistance and derivatives also affect the improvement of problem-solving abilities and knowledge of thermodynamic mathematics. Based on the findings [29] through mathematical games can also improve mathematical knowledge.

4 CONCLUSION

Based on the results of the analysis and discussion, it can be concluded that trough learning CollaPs models assisted by interactive simulations and derivative games can improve the thermodynamic solving problems ability for a prospective physics teacher. Improvements to aspects; the problem schema, analogy, causal and argumentation of the experimental group had higher N-Gain values compared to the control group. However, the problem schema has a smaller N-gain compared to other aspects as a material for improvement, students must learn to categorize problems in the type of problem (that is, schemes based on mathematical structures) on thermodynamics, applying efficient solution strategies for each problem scheme, and understand the problems meaning.

5 ACKNOWLEDGMENT

Terima kasih kepada LPDP (Lembaga Pengola Dana Pendidikan) dari Kementerian keuangan indonesia yang telah memberikan kontribusi dalam penyelesaian penelitian.

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