



Improving Problem Solving Skill in Physics through Argumentation Strategy in Direct Instruction Model

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Abstract

This study aims to improve problem solving skill of Physics Education students in ULM Banjarmasin, Indonesia. Problem solving is part of 21st century skills which is recommended by Kerangka Kurikulum Nasional Indonesia (Indonesian National Curriculum Framework). This study starts by operationalizing the direct instruction model syntax and including the argumentation strategy in form of teaching material, then implementing the strategy using a valid teaching material. In order to see the effectivity of learning strategy, the implementation is done to 92 Physics teacher students in Faculty of Teacher Training and Education Lambung Mangkurat University who are registered in Thermodynamics module as the research subject. Pretest and posttest are conducted to gain data of strategy effectivity in improving students' problem solving skill by using the analysis of normalized gain score. Problem solving skill test shows that the pretest average score of 28.89 is increased to 71.74 in the posttest with N-gain of 0.60 and it includes in medium category. Based on the research result evaluation, it is concluded that students' skill in Physics problem solving in Thermodynamics on the topic of kinetic theory of gas can be improved by implementing the argumentation strategy in direct instruction model.

Keywords: problem solving; direct instruction; argumentation strategy.

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1. Introduction

The reformation of education and integration of 21st century skills on Physics learning need to be continuously done. Therefore, Indonesian government has developed and applied Kerangka Kurikulum Nasional Indonesia (KKNI) or Indonesian National Curriculum Framework to achieve college graduates competence standards which fit the job demands and 21st century skills demands. Physics teaching needs to be shifted into what students do in learning science [1], which is the dialogic process in building the knowledge to make explanation, prediction, and reasoning that take students' thinking skill into account. This condition needs adaptation of the needed skill which is problem solving skill that includes in the 21st century skills [2,3].

Problem solving is one of the 21st century skill which is recommended to be owned by individual in daily life. Problem solving skill as a mental and intellectual process which is used by students to relate the prior knowledge and the problems they are facing, and also call on the past experience of problem solving so that they get a solution of the problem [4]. Problem solving has the components of filing argument, strategy identification, and evaluation of solution [5]. Argumentation itself is viewed as an important thing in science learning because it is a very basic core activity in which students need argumentation to strengthen their understanding in learning [6]. Argumentation is defined as reasoning process which contributes in the activity of considering alternative in a situation or theory. Scientific argumentation can help students to improve knowledge and support their problem solving skill.

Experts see Physics as general and coherent concepts structure which describe the nature and use systematic approach, reasoning, problem solving based on concept which is applied in various situation [7]. A good implementation of Physics learning can promote intellectual development. Intellectual mental development does not aim to produce more scientists, but develop their thinking potentials [8, 9]. Thermodynamics is a knowledge to learn the relationship between heat and work, and the characteristics supporting it. It also can be said that thermodynamics teaches about energy and transformation [10]. Learning thermodynamics needs three approaches, which are macroscopic, statistic, and microscopic. Prior observation result shows that students have difficulties in understanding thermodynamics concepts and lack ability in thermodynamics problem solving during the lectures.

Observation result also shows that the used method in lectures is still oriented on students' learning outcome, not on the development of thinking skill such as problem solving skill. Based on the facts, an appropriate learning strategy is then needed by integrating argumentation in direct instruction model to improve physics problem solving skill in Thermodynamics module.

2. Riview of Literature

Innovative learning is essential in actualizing all the competences which are suitable with Kerangka Kurikulum Nasional Indonesia (Indonesian National Curriculum Framework) and 21st century skills. Learning process ought to give students an ability to construct knowledge in their cognitive process. In order to deeply understand and apply the knowledge, students need to be encouraged to solve problems and find knowledge.

Thermodynamics is a particular chapter of Physics [11]. Learning Thermodynamics needs three approaches; macroscopic, statistic, and microscopic. It needs a correct strategy to make students be able to master the concepts and own a problem solving skill.

Direct instruction is an approach which teaches about basic skills for subjects that is oriented on a strictly structured learning purpose and environment [12]. Direct instruction model is particularly designed to develop declarative and procedural knowledge given by gradual activities pattern, step by step [13]. Therefore, direct instruction is a learning model which teaches students about a structured declarative and procedural knowledge which is oriented on purpose. Students' skill in arguing scientifically by linking data/facts to a statement can make students critical attitude grows. Argumentation is related to the process of gaining and arranging those components [14]. One of the indications to learning transfer is the ability to use information gained by students to solve the problem [15]. Problem solving components are filing argument, strategy identification, and evaluation of solution [15].

3. Methods

The focus of this study is improving students' problem solving skill in Physics by using argumentation strategy in direct instruction model in thermodynamics module. This research goes through these stages: (a) direct instruction model syntax by including argumentation strategy which is operationalized in form of thermodynamics teaching material, (b) implementing the strategy by using a valid teaching material.

In order to see the effectivity of learning strategy, it is implemented to 92 Physics students which are registered in thermodynamics module as the research subject. The used instrument to collect data is a problem solving test instrument with the indicators of filing argument, strategy identification, and evaluation of solution. Pretest and posttest are done to see the effectivity of strategy in improving students' problem solving skill, then the gained data is analyzed by using normalized gain score analysis. Normalized gain score analysis is based on the following formula [16]:

$$g = \frac{\%S_f - \%S_i}{100\% - \%S_i}$$

With:

g = normalized gain

S_f = pre-test score

S_i = post-test score

The data gained in implementation stage is consulted on Table 1 to see the effect of learning strategy which is developed toward the improvement of problem solving skill. The reference of gain score [16] is as following:

Table 1: Gain score reference

Scale	Criteria
$\langle g \rangle > 0.7$	High-g
$0.7 > \langle g \rangle > 0.3$	Medium-g
$\langle g \rangle < 0.3$	Low-g

4. Results and Discussion

The effectivity of argumentation strategy in direct instruction model to improve physics students' problem solving skill in thermodynamics module can be seen on the following Table 2.

Table 2: Problem solving skill test result

	Pre-Test	Post-Test
Number of students	92	92
Highest score	41,67	87,5
Lowest score	25	54,17
Total average	28,89	71,74
N-Gain	0,60	

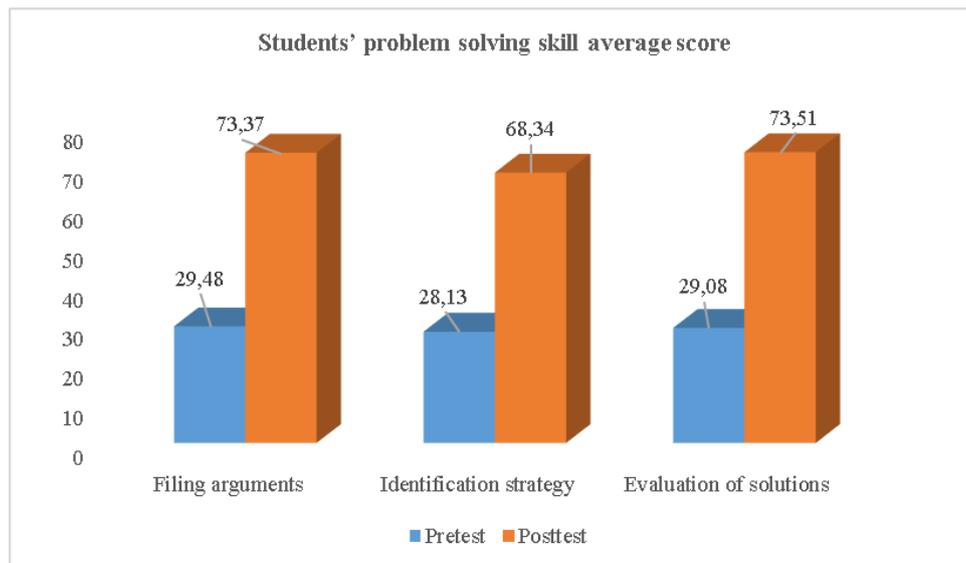


Figure 1: Students' problem solving skill average score

The implementation of direct instruction model with argumentation strategy has positive effect on the improvement of Physics students' problem solving skill. Problem solving skill test result on Table 2 generally shows the improvement of average score from pretest to posttest. The average score on pretest which is 28.89 is increased to 71.74 on the posttest with N-Gain of 0.60 and it is included in the medium category. If we see Figure 1, it shows that average scores overall for problem solving skill components which are measured for filing argument, strategy identification, and evaluation of solution are increased significantly, the improvement is more than 50% of the previous score that students get. The average score of filing argument skill is increased from 29.48 on pretest to 73.37 on posttest, average score for strategy identification skill is increased from 28.13 on pretest to 68.34 on posttest, and average score for evaluation skill of solution is also increased, which is 29.08 on pretest to 73.51 on posttest.

The stages of direct instruction model implementation by using argumentation strategy is done in these following steps. On phase 1 of direct instruction model, researcher tells the purpose of research and get the students ready. Researcher also explains the outline of material which will be learned and builds the students' confidence to reach the learning purpose. The learning activity then continues to the phase 2. On the phase 2 of knowledge demonstration, researcher teaches the way to solve problems with the steps of filing arguments, strategy identification, and evaluation of solution. Researcher gives emphasis on how to identify the correct strategy in solving a physics problem. After problem solving step is demonstrated, continues to phase 3 of direct instruction model which is guiding. On this phase, students learn to follow the steps which is already explained by researcher (imitation). It corresponds the theory of social learning which is explained by Albert Bandura in which students can learn through imitation and presentation of behavioral examples (modeling). Researcher checks students' understanding and gives feedback on phase 4. On this phase, researcher gives assignment whose difficulty level is harder than the exercise and question example. It aims to check students' understanding. Researcher then gives feedback, it is done in the same time when students compare their answers with the answer key, and also gives motivation to students' answers. The last phase is giving opportunity for advance learning and application, researcher gives homework to students and conclude the lesson. Thermodynamic teaching that implements phases of filing argument, strategy identification, and evaluation of solution in the direct instruction model has proved effective in improving student problem solving skill.

5. Conclusion

According to the research result evaluation, the conclusion is students' skill in Physics problem solving in thermodynamics module on the topic of kinetic theory of gas can be improved through the implementation of argumentation strategy in direct instruction model.

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