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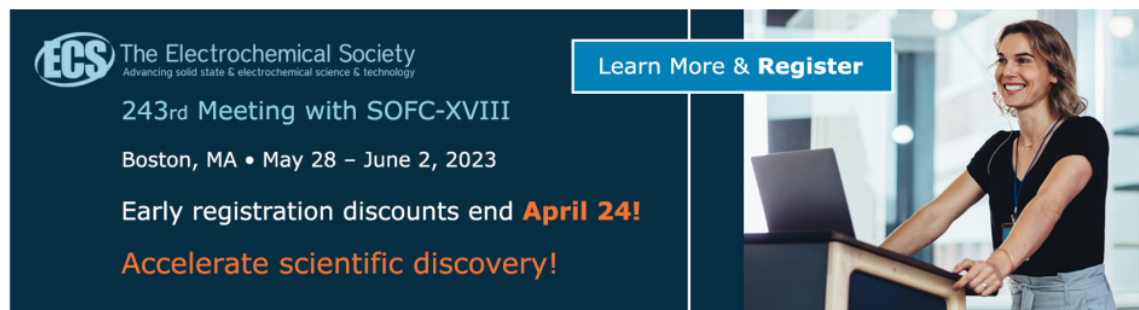
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Improved problem-solving skills of the student through cooperative problem-solving models related to fluid dynamic topic

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Abstract. Problem-solving skills (PSS) were needed to prepare for the working world. Based on a preliminary study at one of Senior High Schools in Banjaran West Java, the average score of student Problem-Solving Skills (PSS) was low. This study aims to determine the improvement of PSS of student after applied Cooperative Problem Solving (CPS) models on dynamic fluid. The research method used was a pre-experiment with one group pretest-posttest design. The subjects of this study were students of class XI Science 2 selected by purposive sampling technique amounted to 30 people. The student's PSS was measured through an essay test and a supporting instrument in the form of student worksheets. The results showed that there was an increase of PSS of students with $\langle g \rangle$ of 0.68 medium categories. Based on the paired sample t-test where $t_{\text{count}} (12.24) > t_{\text{table}} (2.05)$ indicates that there was the influence of CPS models to improve PSS of students. The average results of the student worksheet analysis indicate that there was an increase student's PSS at each meeting and the average value was categorized well. Thus, the CPS models can be used as an alternative learning model that can improve PSS of students on dynamic fluid.

1. Introduction

Students for the challenges to the 21st century must be able to demonstrate a range of skills such as problem-solving, think critically, communicate effectively, be teamwork, ability to work on own initiative and adapt to the environment changes rapidly [1-3]. Learning physics requires students to have problem-solving skills. Students need learning conditions to be situated in a real work situation in their daily lives and learning experiences of other more authentic [4]. Problem-based learning approach



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considered appropriate to involve the use of intelligence of the individual, or groups of people and the environment to solve the problem of meaningful, relevant and contextual [5,6].

Problem-solving skills are high-level thinking skills in the process involves the acquisition and organization of information to find the solution to a problem with a systematic and proper procedural. Problem-solving skills become a vital part of education and can be developed if the students accustomed to dealing with problems that are non-routine [7]. Solving problems of science includes the ability to reason, read the statement of the problem, decompose problems, perform analysis, looking for relationship issues with the appropriate mathematical formulas, back to examine the solutions and make effective decisions [8,9].

One model of learning that can be used to enhance students' problem-solving skills are a model Cooperative Problem Solving (CPS). CPS model helps to enhance complex thinking skills of students including problem-solving. The implementation CPS model in groups makes students share conceptual and procedural knowledge when solving problems together. In addition, the CPS model to raise many learning activities for students faced with the problem, formulate and test the truth about the hypothesis to draw conclusions as the answer to a problem [10,11].

Based on the results of previous studies, the model of Cooperative Problem Solving (CPS) can be implemented well in school because it can improve student learning outcomes and be alternative learning models could be used to improve students' higher-order thinking skills. The CPS model can improve student learning outcomes [12], creativity and learning outcomes [13], the activity and student achievement [14], critical thinking skills [15], creative thinking skills [16,17] and the ability to cooperate [18]. The contrasts to previous studies, this researches of implementation CPS model to improve students' problem-solving skills related to the topic of dynamic fluid. In addition, this research novelty integrates the CPS model with laboratory activity.

2. Methods

The research method used was pre-experimental with one group pretest-posttest design. The population of this study was all class XI-Science at one of senior high school in Banjaran amounting to 5 classes. Samples were class XI-Science 2 with the number of students 30 people. The sampling technique used purposive sampling technique. The sample was chosen with the consideration of having a better learning achievement compared to other classes.

The instrument used in this study was the problem-solving skills test and student worksheet. Indicators, the rubric of problem-solving skills assessment tests and student worksheet refer to a framework Docktor & Heller consist of useful description; approach to physics; specific approach to physics; the proper use of mathematics; and the logical progression [19]. The researched instrument problem-solving skills of students related to fluid dynamic include the equation of continuity, Bernoulli law, and application of the Bernoulli law that consists of four essay questions. The student worksheet is used as a medium to train students' problem-solving skills during learning model Cooperative Problem Solving. Student worksheets consist of five questions related to problem-solving skills indicator is given for 3 times meeting about dynamic fluid.

The improved student problem-solving skills were calculated using normal gain and interpretation according of Hake's criteria [20]. Analysis of student worksheet data by assessing the results of student work by matching student answers with the answer keys that have been made; calculating the number of scores obtained by students divided by the maximum score multiplied by 100; interpreting scores obtained by students based on the Arikunto category [21]. Interpretation of scores on student worksheets according to Arikunto was the criteria for failure (30-40); less (40-55); enough (56-65); good (66-79), very good (80-100). The hypothesis test was done using parametric statistics are paired samples t-test. This test was done to see the effect of applying the CPS model for improving students' problem-solving skills. Before testing the hypothesis, the normality test was done first using the Lilliefors test.

3. Result and Discussion

The enhancing of students' problem-solving skills related to the concept of dynamic fluid with comparing the average score pretest, posttest and normalized gain (<g>) are shown in Table 1.

Table 1. The improved problem-solving skills of students

	Scores		<g>	Interpretation
	Pretest	Posttest		
Sum	1324.20	2466.20	0.68	Medium
Average	44.14	82.20		

The improved problem-solving skills of students included in the medium category with an average normalized gain is 0.68. The average value of pretests and posttest are 41.80 and 81.30. Therefore, there is an increase in the problem-solving skills of students after the applied model of Cooperative Problem Solving (CPS) related to the concept of fluid. CPS model improved students' skills in discussions to understand and apply knowledge in the context of real-world problems, the process is more structured problem solving, and problem-solving skills increased [10]. These results are consistent with previous research, achieving and learning of problem-solving oriented, integrated with laboratory activity can improve critical thinking skills and creative thinking of students [22-24]. Distribution of the average score for each indicator the student's problem-solving abilities demonstrated by comparing the average score pretest, posttest and normalized gain (<g>) related to the concept of dynamic fluid are shown in Table 2.

Table 2. The improved every indicator of students' problem-solving skills

No.	Indicators problem-solving skills	Score		<g>	Interpretation
		Pretest	Posttest		
1	A useful description	45.20	81.67	0.65	Medium
2	Physics approach	38.00	75.30	0.60	Medium
3	Specific physics approach	49.50	88.20	0.77	High
4	Mathematical procedures	40.00	76.67	0.61	Medium
5	Logical progression	48.00	89.17	0.79	High
	Average	44.14	82.20	0.68	Medium

Each indicator of students' problem-solving abilities increases to include the medium and high category. The improved problem-solving ability of students consists of three indicators of medium category and two indicators including the high category. The indicator of students' problem-solving skills with the acquisition of <g> the highest is the indicator of a logical progression of a high category. Indicator with the acquisition of <g> the lowest is indicator physics approach to the medium category. Details of the number of increased student's problem-solving skills with the high category as many as three students (10%), 27 students (90%) gain medium category and there are not students with the low category.

Logical progression indicators into indicator problem-solving skills with the acquisition of the highest score due to the problems presented an implementation of the concepts of physics in everyday life the students are able to find the solution to problems and explain it properly. Students have prior experience in laboratory activity indicates metacognitive strategies to solve the problem-solving skills higher than students with no experience of laboratory activity [25].

Problem-solving skills of the student at the indicator approach experience the lowest increase because students have not been able to explain the concepts of physics which they select in detail. The most students just are given formula without understanding the concept during learning. According to Tietmeyer, students often do not pay attention to the relationship between the real world with the subject of physics and they are only intended to practice law and the formula has been studied [26]. Lin and

Singh also said that knowing and understanding the basic principles of physics is one of the most important components to settle problem [27].

The results of student worksheets assessment based on indicators of problem-solving skills are shown in Table 3.

Table 3. The student worksheets assessment based on indicators problem-solving skills

No.	Indicators problem-solving skills	Meeting to-			Average
		The equation of continuity	Bernoulli law	Application of the Bernoulli law	
1	A useful description	59.70	64.80	71.90	65.47
2	Physics approach	53.40	57.90	64.80	58.70
3	Specific physics approach	61.60	66.90	74.70	67.73
4	Mathematical procedures	56.30	63.70	69.60	63.20
5	Logical progression	64.60	70.40	77.80	70.93
Average		59.12	64.74	71.76	65.21
Interpretation		Enough	Enough	Good	Enough

Each indicator of the problem-solving skills of students has increased on every meeting. The improved problem-solving skills of students in learning related to the equation of continuity and Bernoulli law both were categorized enough. The problem-solving skills of students on third learning related to Bernoulli law application have increased including good categories. The indicator logical progression experienced the highest increase in any meeting. Indicators physics approach experienced the lowest increase in every meeting.

This improved of two indicators indicate suitability with an average of pretest, posttest and normalized gain previously described. Results of the assessment on student worksheet at every meeting affect the improvement to students' problem-solving skills. If students do not understand the basic principles that will tend to make mistakes when solving problems. The biggest difficulty the student is applying the principles of physics to the correct and relevant [27-28].

The results of the normality test using the Lilliefors test showed that the pre-test data were normally distributed with $L_{count} (0.092) < L_{table} (0.162)$ at a significance level of 0.05. The calculation of data pre-test show $L_{count} (0.079) < L_{table} (0.162)$ with a 0.05 significance level showed normal distribution. The pre-test and post-test data showed normal, the hypothesis testing using a paired sample t-test to determine the effect of CPS models to increase students' problem-solving skills. The calculation shows $t_{count} (12.39) > t_{table} (2.05)$, thus there is an increase in problem-solving skills of students after CPS models applied. The results of this study reinforce previous research administration complex and contextual issues will help train students in physics problem solving skills [29], creative thinking skills [30] and communication skills [31].

4. Conclusion

We have been successful in a research of the application of the model Cooperative Problem Solving (CPS) to improve student problem-solving skills related to the concept of dynamic fluid. The increasing students' problem-solving skills including the medium category. The results assessment of student worksheet shows each meeting using the Cooperative Problem-Solving model can increase each indicator of the problem-solving skills of students. Therefore, the application of the model Cooperative Problem-Solving could be used as an alternative model to improve the complex thinking skills of students in other physics topics.

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