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The Effectiveness of Creative-Inquiry-Based Student Worksheet in Improving Physics Self-Efficacy and Problem Solving of Senior High School Students

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Abstract. The objective of this research is to describe the use of creative-inquiry-based student worksheets in improving physics self-efficacy and problem solving of senior high school students. This was quasi-experiment research with pretest and posttest control group design. Samples were taken using the purposive sampling technique. They were the twelfth-grade students of Public Senior High School 7 in Bandar Lampung and Public Senior High School 1 in North Sungkai. Samples were divided into two groups; the experimental group taught by using a creative-inquiry-based student worksheet and control group taught by using student worksheet sold freely in the market. Instruments used were self-efficacy sheets and problems to test physics problem-solving ability. The data were analyzed by using descriptive analysis with percentage technique, N-gain, and independent t-test. The result showed that a creative-inquiry-based student worksheet is effective to be used to improve self-efficacy and ability of physics problem-solving. Good self-efficacy will have implications for the level of physics problem-solving ability in solving physics problems.

Keywords: creative inquiry, problem-solving ability, self-efficacy.

1. Introduction

The physics subject curriculum demand is basically to assist learners to understand concepts and problem-solving in daily life. The final objective of physics learning is to solve the problem. Physics problem solving is complicated because most physics problems are abstract and complex [1] and they involve complicated mathematics [2] so that most students find it difficult.

The preliminary study showed that 83% of students did not like physics subjects because they found physics too difficult with limited time capacity, physics materials were abstract and using too many difficult to understand formulas, and having less varying learning media. Students expected learning would be presented in varying and creative ways by using understandable student worksheets. Most teachers in Lampung province, Indonesia, present lessons in less varying ways and by using student worksheets made by other parties that may be less suitable with student's characteristics, material difficulty levels, and objectives to obtain. Teachers in learning are also less directing students to higher-order thinking skills (HOTS) so that students find difficulties in problem-solving. This is consistent with previous research by Purnamawati which states that student worksheets can be used as learning innovations based on the higher-order thinking skills that are analyzing (C4) and creating (C6) [3].



In physics, students should have high self-efficacy, so that they would master materials properly. Self-efficacy (an ability to control the mind, feeling, and behavior) are very required by students to motivate themselves in problem-solving. Lack of problem-solving ability results in lower student's self-efficacy, while high academic ability can improve student's self-efficacy [4]. If the student's physics problem-solving ability score is high, the higher the student's self-efficacy [5] Self-efficacy refers to a student's confidence to obtain in the learning activity [6]. Self-efficacy also influences a student's selection in setting behavior, efforts in finishing tasks, and time duration the student will endure to face obstacles [7]. A strong self-efficacy can encourage or generate motivation to overcome obstacles or challenges. Low self-efficacy would tend to reduce efforts and be easy to give up, and an easy problem would be the hard one. These indicate that self-efficacy influences students' characteristics, mindsets, and behaviors. Problem-solving according to Anderson [8] is a life skill involving processes of analysis, interpreting, reasoning, predicting, evaluating, and reflecting. Polya [9] affirms that problem solving is made as an effort to seek problem solutions from difficulty or problem. According to Savage & Williams [10], the source of this problem is actually not only we can bestow on students, but the role of the teacher here is very important, problem-solving in physics contains 3 steps; they are 1) setting/preparing model, 2) analyzing problem, 3) interpreting and validating. Solving a problem should not always be using the same way, each individual can use their ways according to their abilities [11,12]. The student's problem-solving ability is not merely depending on the student's maturity level, but also depending on the problems that the student directly experiences.

In learning, there are some efforts that teachers can make to improve student's self-efficacy that would motivate the students in problem-solving, such as student worksheets with material elaborations following the creative inquiry model. Student worksheet in learning is very potential as an alternative to improve physics problem solving [13]. When a student can solve various physics problems, it would improve the student's self-efficacy and vice versa. Also, by using student worksheet, it would help teachers in delivering students to find concepts and apply them creatively by their activities or working group [14]. The inquiry is an active learning model, where the student is active to pose questions so that the student would be able to solve difficult problems. Learning by using a creative inquiry model can improve student's motivation and talent [15]. The creative inquiry model provides feedback in learning that gives rise to student activity [16]. Thus, a creative inquiry-based student worksheet is needed that can improve self-efficacy and the ability to solve physics problems. Therefore, it is necessary to test the effectiveness of creative inquiry-based student worksheets that can improve students' self-efficacy and physics problem-solving abilities.

2. Method

This was quasi-experiment research with a pre-test-post-test control group design. 132 samples were taken by using purposive sampling technique. Samples were 66 twelfth grade students in Public Senior High School 7 in Bandar Lampung and 66 twelfth grade students in Public Senior High School in North Sungkai, Indonesia. Students in each of those high schools were divided into an experimental group consisted of 33 students and a control group consisted of 33 students. The experimental group was taught by using a creative inquiry-based student worksheet and the control group was taught by using student worksheets obtained from the bookstore. Pre-test and post-test were given to each group. The self-efficacy instrument contained 10 questions following the self-efficacy instrument developed by Schnetzer and Yerusalam[17], while problem solving ability instrument contained of 6 problems of problem solving developed by Savage and William [18]. Before being used, the instrument was tested for validity and reliability. The research design can be seen in Table 1 [19].

Table 1. Research Design

| | | | | |
|---------------|---|---|---|---|
| Eksperimental | M | O | X | O |
| Control | M | O | C | O |

N-gain test was conducted by using gain formula according to Meltzer [20].

$$\text{Gain} = \frac{\text{Posttest score} - \text{pretest score}}{\text{maximum score} - \text{pretest score}}$$

The estimation result was interpreted by using normalized gain according to Meltzer classification that can be seen in Table 2.

Table 2. Classification of N-gain score

| Normalized gain score | Interpretation |
|-----------------------|----------------|
| $g > 0.7$ | High |
| $0.3 < g \leq 0.7$ | Moderate |
| $g \leq 0.3$ | Low |

3. Result and Discussion

The effectiveness of creative-inquiry-based student worksheets in improving self-efficacy and ability for physics problem solving was measured by using N-gain difference between experiment and control group. The pre-test, post-test, and N-gain scores of student's efficacy are shown in Table 3.

Table 3. Pre-test, post-test, and N-gain score of self-efficacy

| School | Aspect | Class | Pretest | Posttest | N-gain | Criteria | P |
|---|---------------|--------------|---------|----------|--------|----------|--------|
| Public Senior High School 7 in Bandar Lampung | Self-efficacy | Experimental | 18.90 | 35.39 | 0.77 | High | 0.001* |
| | | Control | 19.47 | 30.64 | 0.53 | Moderate | |
| Public Senior High School 1 in North Sungkai | Self-efficacy | Experimental | 20.93 | 36.78 | 0.83 | High | 0.001* |
| | | Control | 18.11 | 31.14 | 0.57 | Moderate | |

* $p < 0.05$, significantly different at trust level 95%

Table 3 shows that N-gain averages of students' self-efficacy before learning, both in the experimental and control classes, are low, 19.91 for experiment class and 18.79 for control class. After learning, self-efficacy average scores improve into 36.09 for experiment class and 30.89 for control class. N-gain of experiment class by 0.80 belongs to the high category and n-gain of control class by 0.55 belongs to moderate category. The independent t-test result shows that N-gains between experiment and control class differ significantly. This indicates that creative-inquiry-based student worksheets being used in effective learning improve students' self-efficacies. Before using creative-inquiry-based student worksheets, students were less confident in their abilities in problem solving and students were only able to solve a few physics problems. This finding is supported by Tezer and Asiksoy[21] that students with higher academic ability would have more confidence and better self-efficacies. The more the students can solve physics problems, then the better will be the students' self-efficacies and vice versa. Learning by using a creative-inquiry-based student worksheet can improve students' motivations and talents [22]. In creative-inquiry-based student worksheet, students are active to do an observation, problem identification, problem formulation, problem analysis, discussion, and self-reflection, so that a previously difficult problem becomes easier to understand by students. This finally improves students' self-efficacies. The research finding shows that inquiry-based learning can

improve students' self-efficacies. After learning, students are more confident, able to overcome difficulties, calmer, and able to use different strategies in problem-solving.

The effectiveness of a creative-inquiry-based student worksheet is also able to improve physics problem-solving. The pre-test, post-test, and N-gain scores of problem-solving ability are presented in Table 4.

Table 4. Pretest, posttest, and N-gain scores of problem-solving ability

| School | Aspect | Class | Pretest | Posttest | N-gain | Criteria | P |
|---|-----------------|--------------|---------|----------|--------|----------|--------|
| Public Senior High School 7 in Bandar Lampung | Problem-solving | Experimental | 36.84 | 77.06 | 0.64 | Moderate | 0.000* |
| | | Control | 40.88 | 59.14 | 0.28 | Low | |
| Public Senior High School 1 in North Sungkai | Problem-solving | Experimental | 35.51 | 78.15 | 0.62 | Moderate | 0.000* |
| | | Control | 40.41 | 58.97 | 0.28 | Low | |

* $p < 0.05$, differ significantly at trust level 95%

Table 4 shows that average N-gain scores of student's problem-solving abilities belong to a low category by 36.17 in experiment class and 40.41 in the control class. Before learning, students were only able to write or describe what they had recognized and what that had been questioned, and only a few students were able to write formulas to use and to try to solve problems, but the results were beyond expectation. In the interpretation stage, no student was able to do it. Table 3 shows that after learning, the average scores were 77.61 for the experiment class and 59.01 for the control class. N-gain average scores were 0.63 for experiment class that belongs to the moderate category and 0.28 for control class that belongs to the low category. Independent t-test result shows that N-gain scores for problem-solving ability between experiment and control class differ significantly. This indicates that creative-inquiry-based student worksheet used in active learning is effective in improving physics problem-solving abilities of students. The creative inquiry is active learning that enables students to focus on making knowledge and emphasizing skills such as analytical thinking, problem-solving, questioning, and metacognition activity. After creative inquiry-based learning had been implemented, students can describe and explain variables they have recognized, to analyze, and to interpret. In problem-solving, students are still weak in interpreting.

The student worksheet developed contains picture illustrations. also, there is a practical simulation so that it can provide opportunities for students to formulate problems to validate the problem. Students can create their findings according to the creative inquiry model. The creative-inquiry-based student worksheet enables students to participate actively in the learning process to observe, formulate the problem, analyze a problem, solve the problem, discuss, and do self-reflection. According to Yanti[23], active learning makes students thinking critically, questioning actively, and solving the problem. This research also found that students felt joy, worked in fun and was not bored. The same finding is suggested by Guler [24] that students are enjoyable and instructive in inquiry learning. Inquiry-based learning also makes students feeling more fun and not bored with learning [25]. Seen when students demonstrate experiments and communicate understanding in a good and deep. Students can clearly distinguish ideas, put forward hypotheses well, be able to solve problems, be able to understand complex things more clearly. Learning by using creative inquiry model worksheets has proven to be effective in improving students' self-efficacy and physics problem-solving abilities.

4. Conclusion and Recommendation

Learning by implementing a creative-inquiry-based student worksheet is effective in improving self-efficacies and physics problem solving abilities of grade XII students and this is indicated by significant different of n-gain scores average of self-efficacy and physics problem solving ability between experimental and control class. The n-gain score average of self-efficacy of the class taught with a creative-inquiry-based student worksheet is 0.80, and it belongs to the high category. The n-gain score average of self-efficacy of the class taught with student worksheets from the bookstore is 0.55, and it belongs to a moderate category. The n-gain score average of physics problem-solving ability of the class taught with a creative-inquiry-based student worksheet is 0.63, and it belongs to a moderate category. The n-gain score average of physics problem-solving ability of the control class is 0.28, and it belongs to the low category. The creative-inquiry-based student worksheet implementation can motivate students to learn, students enjoy learning with a fun working and do not get bored. Teachers are recommended to use student worksheets of their designs by using creative inquiry learning to improve self-efficacy and problem-solving in teaching physics. Further research can be developed in an integrated e-learning student worksheet to be able to add simulations and animations to physics experiments.

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