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Research Article

Learning on Physics Concept Mastering and Critical Thinking Ability in High School Students

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Abstract.
This study aims to determine the differences in concept mastery and critical thinking skills of students who study with computer animation-assisted problem-solving strategies and conventional learning. This research is quasi-research with a posttest-only design. Data were collected by using 20 questions for the concept mastery test and 5 questions for critical thinking skills after being given treatment in 3 different class groups. The first group is students who study computer animation-assisted problem-solving strategies, the second group is students who learn problem-solving strategies, and the third group is students who learn conventionally. Before the treatment and data collection, the instruments used had gone through expert tests and trials. The processed data were analyzed using the multivariate of Anova and then further tested with the Tukey test. The results of this study indicate that problem-solving strategies assisted by computer animation is better than conventional learning and problem-solving strategies to increase students' mastery of physics concepts and students' critical thinking skills.

Keywords: physics concept mastering, critical thinking

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1. INTRODUCTION

Problem-solving learning strategy is a learning concept that relates the material being taught to the problems faced daily. In this learning strategy, students are expected to be able to solve physics problems according to the understanding of each student based on the knowledge they already have. Learning Strategy Problem Solving is one of the learnings that applies student-centered. Problem-solving learning strategies are an important focus in learning physics because the main goal of learning physics is to train students to become reliable problem solvers [1–6]. With this strategy, it is hoped that learning will be more meaningful for students so that what has been obtained is not easily forgotten. The learning process with problem-solving takes place naturally in

the form of student activities working and experiencing, not just transferring knowledge from teacher to student.

Problem-solving learning strategies can improve physics learning outcomes because they have several advantages or characteristics that are following the field of physics study: 1. Can solve problems according to the selected stages, using brainstorming and problem investigation techniques, 2. Build knowledge that has been owned and gain new knowledge through case studies, 3. Can use laboratory tools related to the given theory, 4. Use existing media, and can perform analytical techniques, 5. Analyze, describe and discuss the results of practicum data using written reports, posters, and oral presentations, 6. Students work in groups by organizing each group [7]. One of the interesting learning media to collaborate with problem-solving learning is computer animation media. Computer animation emphasizes the relationship between real-life phenomena and the underlying science, supports an interactive and constructivist approach, provides feedback, and provides a creative workplace [8].

The advantage of computer animation is that it can perform experiments ideally, which cannot be done using real tools. This computer animation was chosen because this simulation can show things that conventional activities cannot do. Computer animations consist of objects that are invisible to the naked eye in the real world, such as atoms, electrons, photons, and electric fields. Students can interact through images and intuitive controls which include click and drag, slide switches, and buttons. With the animations presented, students can investigate the causes and effects of the phenomena presented.

Learning that collaborates problem-solving learning strategies and computer animation media is expected to create an interesting learning atmosphere, make students more active, and increase students' motivation to understand physics so that it can help students improve their mastery of physics concepts and students' critical thinking skills.

Problem-solving steps assisted by Computer Animation, namely: understanding problems, planning problem-solving, implementing problem-solving plans, utilizing computer animation media, and evaluating problem-solving. Problem-solving steps, namely: understanding the problem, planning problem-solving, implementing the problem-solving plans, and evaluating problem-solving [9].

This research needs to be done to determine the mastery of physics concepts and critical thinking skills in students who participate in problem-solving assisted by computer animation, problem-solving, and conventional learning so that they can be

used as references by the teacher, lecturers, and academic practitioners to improve students' mastery of physics concepts and critical thinking skills in physics learning.

2. RESEARCH METHOD

This research is in the form of a quasi-experimental study using three classes, namely two experimental classes and one control class. The first experimental class was given treatment in the form of problem-solving learning strategies assisted by computer animation, the second experimental class was given treatment in the form of problem-solving learning strategies, and the control class was given conventional learning strategies. The design of this study used a posttest-only control group design. This study provides an overview of the comparison of mastery of physics concepts and critical thinking skills of students who study with problem-solving assisted by computer animation media, students who learn by problem-solving, and students who learn by conventional learning.

The population in this study is the first-grade (X) students in the even semester of the 2021/2022 academic year which consisted of 6 classes with a total of 200 students, and the average number of students from each class is 30 students. Samples were taken randomly and class X^1 was selected as the control class, X^3 and X^5 were selected as the experimental class.

Treatment instruments which include syllabus, lesson plans, and worksheets are made and expert validation is carried out. Mastery of students' physics concepts was measured using a test instrument in the form of 20 multiple-choice questions which had previously been validated by 2 lecturers, then a trial was conducted to determine the validity and reliability. The student's physics concept mastery test was obtained from the results of the post-test conducted after the subject of dynamic electricity was completed.

The critical thinking ability test is in the form of a description question. Before the test is given, the instrument for critical thinking skills is validated by expert lecturers. Items have characteristics that describe indicators of critical thinking skills adapted from Ennis [10]. The assessment is carried out with the provisions in the assessment rubric.

Data analysis was performed using multivariate analysis of variance. Before testing the hypothesis, the data were tested for prerequisites, namely: normality test, homogeneity of variance test, variance-covariance homogeneity test, and linearity test.

3. RESULTS AND DISCUSSION

This research will obtain two data, namely mastery of physics concepts and critical thinking skills. Data on mastery of concepts and critical thinking skills were obtained at the end of the study by using multiple choice questions for mastery of concepts and essay questions for critical thinking skills.

Of these data, before testing the hypothesis, prerequisite tests such as the normality test and homogeneity of variance test are carried out. The results of the prerequisite test result that both data are normal and homogeneous.

The normality test of concept mastery data was carried out using SPSS 21.0 for Windows. The summary of the results of the normality test of students' conceptual mastery data is shown in Table 1.

TABLE 1: Normality test results of concept mastery data for students who learn with computer animation-assisted problem-solving strategies.

Group	Kolmonogrov - Smirnov[a]		
	Statistic	df	Sig.
Experiment 1	.143	30	.067
Experiment 2	.144	30	.065
Control	.129	30	.154
[a)] Lilifors Significance Correction			

Table 1 shows the significant value of each group greater than 0.05 so that it can be stated that the class that learns with computer animation-assisted problem-solving strategies (PS + computer animation), problem-solving (PS), and conventional ones are normally distributed. The summary of the results of the normality test of students' critical thinking ability data is shown in Table 2.

TABLE 2: Normality test results of students' critical thinking ability data learning with computer animation-assisted problem-solving strategies.

Group	Kolmonogrov - Smirnov[a]		
	Statistic	df	Sig.
Experiment 1	.117	30	.067
Experiment 2	.143	30	.065
Control	.124	30	.154
[a)] Lilifors Significance Correction			

Table 2 shows the significant value of each group is greater than 0.05 so that it can be stated that the class that learns with problem-solving strategies assisted by Computer Animation (PS + Computer Animation), problem-solving (PS), and conventional is normally distributed.

A homogeneity test was conducted to determine whether two or more data groups had the same variance. In this study, a homogeneity test was carried out using SPSS 21.0 for Windows. The summary of the results of the homogeneity test of students' concept mastery data is shown in Table 3.

Table 3: Test of homogeneity of variances.

Level Statistic	df.1	df.2	Sig.
.069	2	102	.933
2.084	2	102	.13

Table 3 shows a significant result of 0.933. This result is greater than the significance level used, which is 0.05. Thus, it can be stated that the concept mastery data of students who study with problem-solving strategies assisted by Computer Animation (PS + Computer Animation), problem-solving (PS), and conventional have the same variance or are homogeneous. The calculation of the homogeneity test of critical thinking ability data is presented in Table 3. Table 3 shows the results of the significance of 0.130. This result is greater than the significance level used, which is 0.05. Thus it can be stated that the data on critical thinking skills of students who study with problem-solving strategies assisted by Computer Animation (PS + Computer Animation), problem-solving (PS), and conventional have the same variance or are homogeneous.

Based on the prerequisite test, the first hypothesis was tested using the manova test. Manova test results that there are significant differences between students who study computer animation-assisted problem-solving, problem-solving and conventional learning.

The second hypothesis was analyzed using Tukey's test. Tukey's test resulted that the class that studied problem-solving with the help of Computer Animation had a higher mastery of physics concepts than the class that studied problem-solving and conventional learning.

The third hypothesis was analyzed using the Tukey test. Tukey's test resulted that the class that studied problem-solving with the help of Computer Animation had higher critical thinking skills than the class that studied problem-solving and conventional learning.

The results of hypothesis testing indicate that there are significant differences in conceptual mastery between students who are taught using computer animation-assisted problem-solving, problem-solving, and conventional learning. Learning with problem-solving assisted by Computer Animation provides a higher average score compared to problem-solving and conventional. This is following the results of research from

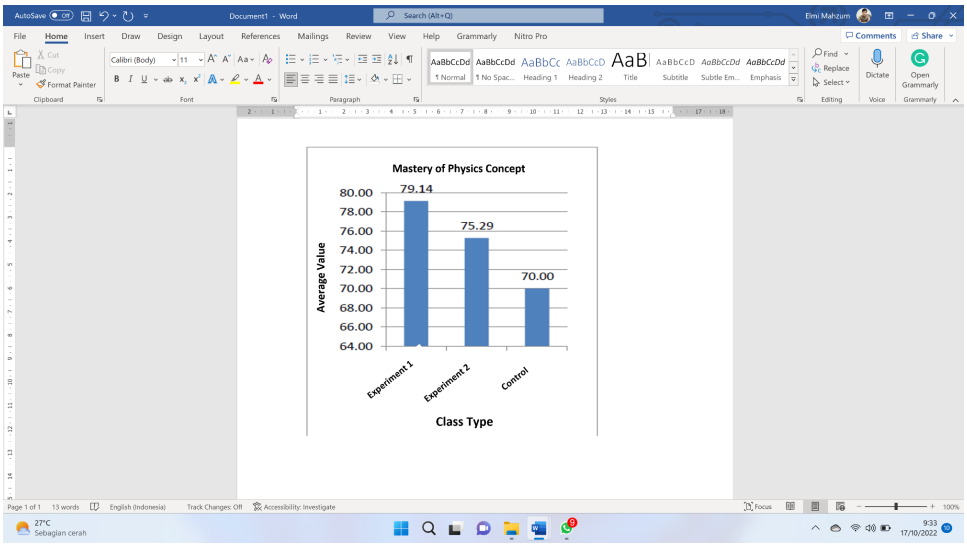

Figure 1: Diagram of the average value of mastery of physics consepts.

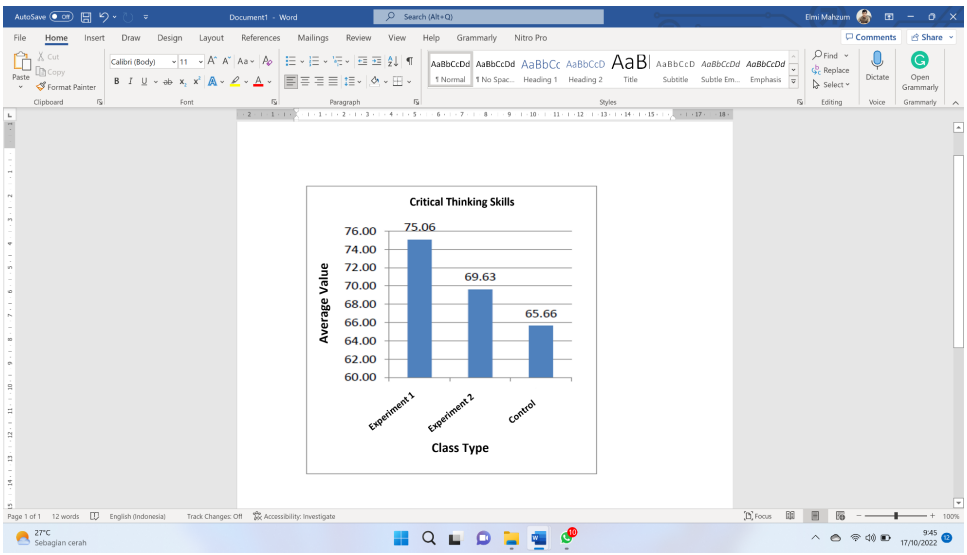

Figure 2: Diagram of the average value of students' critical thinking skills.

Selcuk, et al [11] which states that problem-solving is very influential in increasing physics achievement and problem-solving abilities.

From the research results, problem-solving learning strategies are a very good framework to improve critical thinking skills [12]. The teaching and learning process carried out by the teacher has not maximized the application of learning models following existing theories. Learning activities now seem to only complete teaching obligations which in the end students' mastery of the competencies to be achieved is not realized, so students do not understand the physics concepts being taught [13].

According to Gok [14], people who have experience in solving problems have broad, organized knowledge, that can be used efficiently in problem-solving. Experienced

problem solvers have a different approach to problem-solving than inexperienced problem solvers. Experienced problem solvers solve problems qualitatively according to basic principles whereas inexperienced problem solvers solve problems quantitatively and according to the superficial nature of the problem.

In addition to having several advantages, problem-solving learning strategies also have several weaknesses. These weaknesses include the lack of motivation and persistence of students in planning to solve problems. Even though students have high problem-solving abilities, it is almost useless if they are not motivated to use them [15]. Another weakness in the problem-solving learning strategy is that some of the topics for this strategy are difficult to apply because of the limited laboratory equipment in the practicum, making it difficult for students to see and observe and conclude the event or concept. Problem-solving strategies will also make it difficult for students to plan problem-solving and have limited practical tools, causing students to quickly despair and be less motivated in learning.

These weaknesses can be overcome by utilizing interesting learning media and making students motivated to learn. The presence of learning media can have a positive influence on students. One of the interesting learning media is computer animation media.

Computer Animation Simulation emphasizes the relationship between real-life phenomena and the underlying science, supports an interactive and constructivist approach, provides feedback, and provides a creative workplace. Efforts to improve the mastery of physics concepts and students' critical thinking skills in the learning process can be assisted by the use of computer animation simulations. Physics phenomena and concepts related to simulations and related to students' daily applications can increase students' knowledge visually and stimulate more students to achieve a high level of mastery of physics concepts.

4. CONCLUSION

This study concludes that there is a significant positive effect of applying computer animation-assisted problem-solving strategies and problem-solving on students' mastery of physics concepts and critical thinking skills. Students who study with computer animation-assisted problem-solving gain mastery of physics concepts better than students who study with problem-solving and conventional learning. Students who study with problem-solving assisted by Computer Animation have better critical thinking skills than students who study with problem-solving and conventional learning.

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