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Effectiveness of Cooperative Problem Solving (CPS) Learning with the Science Process Skills Approach on the subject of Simple Harmonic Motion

Rachmat Rizaldi[1], Uswatun Hasanah.S[2], Syahwin[3], Sheila Fitriana[4], Tri Astuti Mardiana[5]
[1,2,3,4,]Islamic University of North Sumatera, Medan, Indonesia

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ABSTRACT

Curpose of the study: The purpose of the research that has been carried out is to analyze the effectiveness of cooperative problem solving learning with the science process skills approach in improving students' understanding of the subject of simple harmonic motion.

Methodology: The method used is a quasi-experiment with a pretest-posttest control group design. The subject of the study was students of class X science from two high schools who were selected purposively. The data was analyzed with a Statistical Descriptive Test to describe the learning outcome data from two sample classes.

Main Findings: The results of the analysis showed that the average posttest score of the experimental class was higher than that of the control class. The average score of the experimental class showed a high improvement category, while the control class only achieved a moderate category. CPS learning with the SPS approach has proven to be effective because it combines group cooperation and scientific exploration. Students can associate theory with practice, so that the understanding of concepts becomes more deep.

Novelty/Originality of this study: This study introduces a novel integration of Cooperative Problem Solving (CPS) with Science Process Skills (SPS) in teaching Simple Harmonic Motion. Unlike traditional methods, this approach fosters both collaborative problem-solving and scientific thinking, enhancing students' conceptual understanding and practical application. It advances existing knowledge by demonstrating how CPS-SPS synergy can bridge theoretical physics and real-world problem-solving skills effectively

Corresponding Author:
Rachmat Rizaldi,
Islamic University of North Sumatera,
Jalan Dr. T. Mansur No.9, Padang Bulan, Kec. Medan Baru, Kota Medan, Sumatera Utara, 20222, Indonesia
Email: rachmat.r@fkip.uisu.ac.id

1. INTRODUCTION

Science education aims to form individuals who have the ability to think critically, creatively, and analytically in solving problems so as to produce sup erior human resources [1]. Superior human resources can be through good education [2], [3]. Next Statement Ariyansah [4] that learning in the 21st century requires students to have various skills, including higher-order thinking skills, problem-solving and science literacy. Simple harmonic motion is one of the basic physics concepts that requires a deep understanding through analytical skills and the application of scientific principles [5], [6]. However, many students have difficulty understanding this material because of the conventional approach that tends to be theoretical.

The Cooperative Problem Solving (CPS) approach focuses on collaborative problem solving in groups [7]. When combined with the Science Process Skills (SPS) approach, this strategy can improve students' ability to observe, classify, formulate hypotheses, and solve physics problems systematically. The problems faced by students in solving physics test problems, many of them do not have the ability to solve problems systematically, it is difficult to digest the main questions, it is not easy to determine the quantities of physics and symbols contained in the questions [8]-[10]. This study aims to analyze the effectiveness of CPS learning with the SPS approach on the subject of GHS.

Harmonic motion is one of the physics learning materials in class XI Science High School which emphasizes knowledge, skills and attitudes, which must be learned by students in order to achieve predetermined competency standards [11]. One of the main challenges in learning physics is how to make students not only understand concepts, but also be able to apply them in various real-life contexts [10]-[13]. This is in line with the statement Septi [14] physics learning is a subject that discusses basic concepts and all the events that occur in it. Simple Harmonic Motion (GHS), as one of the fundamental concepts in physics, is often difficult for students to understand because it involves complex mathematical and modeling aspects. According to Prihatini [15] science learning materials include basic concepts, approaches, methods, and techniques of scientific analysis in the study of various phenomena and problems encountered in real life in society. Another factor that causes students to be not so interested in physics lessons in the classroom is the model used by teachers [16].

The Cooperative Problem Solving (CPS) approach has long been known as an effective collaborative learning method. The CPS model is a learning model that emphasizes creativity as the basic ability of students to solve a problem [17]- [19]. The Creative Problem Solving learning model trains students to solve a problem in various alternative solutions. When combined with the Science Process Skills (SPS) approach, it can have a positive influence on improving student learning outcomes. Science process skills have a positive influence on students' mastery of physics concepts as evidenced through theoretical and empirical analysis [20].

Previous research has shown that conventional approaches to physics teaching are often not effective enough in building higher-order thinking skills. The low ability and lack of student activity are allegedly caused by the learning process that is still teacher-centered [21]. This is influenced by the learning methods used by teachers. According to Prihatini [15] stated that the learning method functions as one of the supports and carrying capacity for the effectiveness of the learning process, so that it can increase learning interest and make it easier for students to learn which in the end students get satisfactory learning results. This is also in line with Wahyuni et al., [22] that teachers must be good at choosing the right learning method for the material taught to their students. On the topic of Simple Harmonic Motion, students' difficulties generally include understanding the concepts of amplitude, period, and frequency, as well as the application of dynamic principles to analyze motion. In contrast, a problem-solving-based approach gives learners the opportunity to actively explore and apply concepts.

Learning with Cooperative Problem Solving can increase the sense of responsibility among students. According to Septi et al., [14] the use of the learning model is highly prioritized in order to generate passion for learning, motivation to learn, and stimulate students to play an active role in the learning process . Furthermore, students are required to carry out activities during the learning process [17]. This method creates an environment that supports intellectual exploration, where learners can learn from each other's perspectives. Learning is one of the factors that plays a role in influencing the process of personal formation and behavior of an individual [23]. With the SPS approach used, it can stimulate students' basic ability to understand science concepts. These science process skills are expected to form an understanding of scientific facts and concepts including processes and products, as well as scientific knowledge and attitudes (Markawi, 2013). According to Siswono [20] that the indicators of science process skills are divided into several aspects, including cognitive, psychomotor, and affective (social) aspects.

This science process skills approach also allows students to be able to develop a scientific mindset that is important in learning complex concepts such as simple harmonic motion. The process skills approach is a learning process that is designed in such a way that students discover facts, build concepts and theories with their own intellectual skills and scientific attitudes [24]-[26].

Simple harmonic motion is a fundamental topic in physics because it is the basis for understanding various natural phenomena, such as oscillations in springs, pendulum motion, and waves. According to Tupalessy et al., [27] stated that material mastery is not just remembering what has been learned, but involves various processes of mental activities that are dynamic. In the research Subekti & Ariswan [23] The low quality of education in Indonesia, especially science learning, one of the reasons is that science learning is not taught in accordance with the characteristics of science itself. This shows the importance of innovative approaches such as CPS supported by SPS to improve students' understanding of physics concepts in GHS. SPS also emphasizes the formation of knowledge acquisition skills and communicating the acquisition [14], [28], [29].

Various studies have supported the effectiveness of the CPS and SPS approaches in physics learning. Students' learning activities are classified as active during learning using the Creative Problem Solving learning model [21]. Meanwhile, according to Alam [24] that the science process skills have parts in the process such as the way of thinking, doing work, interacting communicating, and taking attitudes that are necessary in solving problems in life. The combination of CPS and SPS can increase student involvement in the learning process, improve conceptual understanding, and build scientific thinking skills. The relationship between the techniques used by teachers and learning interests can also affect student learning outcomes [16]. Therefore, the combination of these two approaches is very relevant to be applied to the subject matter of Physics of Simple harmonic motion.

The purpose of the research that has been carried out is to analyze the effectiveness of Cooperative Problem Solving (CPS) learning with the science process skills approach in improving students' understanding of the subject of Simple Harmonic Motion. This study is also useful to contribute to the development of collaboration-based learning theory and science process skills and become the basis for teachers to integrate the CPS-SPS approach in the physics curriculum at the high school level.

2. RESEARCH METHOD

This study uses a quasi-experimental method with design *pretest-posttest control group* [30]. The subject of the study was students of class XI science from two high schools who were selected purposively. The population in this study is students in class XI science high school. Two classes were taken randomly, one as an experimental class to apply CPS-SPS learning and one as a control class for conventional learning. The instruments in this study are Multiple Choice Test Questions, SPS Aspect Observation Sheet to assess students' SPS during learning activities, and Questionnaire of students' responses to CPS-SPS learning. The procedure in this study starts from the preparation of a CPS-SPS-based Learning Implementation Plan. Furthermore, a pretest was carried out to measure the initial ability of students from two classes, and applied CPS-SPS learning in the experimental class for four meetings, then a posttest was carried out to measure the improvement of student learning outcomes and the collection of observation data, as well as a questionnaire of student responses. The data was analyzed by the Descriptive Statistical Test to describe the data of student learning outcomes, before the t-test was carried out, the normality and homogeneity test was first carried out, after the data was normal and homogeneous, the t-test was carried out to compare the average learning outcomes of the experimental and control classes, and then qualitative analysis to process the data of observation results and student response questionnaires. The t-test data analysis technique in this study uses SPSS, while for the analysis of observation data on the SPS aspect and student responses using *Likert Scale* as follows [31].

Table. 1 Likert Scale

Valuation	
Excellent	4
Good	3
Pretty Good	2
Not Good	1

The data obtained will be tabulated according to the respondent's answer choice and continued with the calculation of the SPS Score and Students' Response through the calculation of the average respondent's answer score according to the question item, with the formula:

$$Value = \sum n \times Si/N \qquad ...(1)$$

Where Si = Score of the question item of each aspect, n = Predicate of the item; and N=Number of respondents

Table 2. Item Score

Value	Information
≥ 3.25	Very High
2,75 - 3,24	Tall
2,25 - 2,74	Enough
1,76 - 2,24	Low
≤ 1.75	Very Low

3. RESULTS AND DISCUSSION

The results of data analysis that have been carried out using the t-test show that the average posttest score in the experimental class is higher than that of the control class. These results were obtained using SPSS. The difference in the average values of the two sample classes can be seen in table 1 below.

Table 1. Results of the average score of the two sample classes

Class	N	Mean	Std. Deviation	Std. Error Mean
Experimental Class	32	80.84	5.770	1.020
Control Class	32	75.59	3.015	0.533

In table 1 above, it is known that the average score of the experimental class is 80.84 while the average value of the control class is 75.59. This value shows that the value of the posttest results given in the two sample classes is different. To find out the significant difference from the average results of the two sample classes, a t-test was carried out using SPSS so that the results were obtained as shown in table 2 below.

Table 2. t-Test Analysis Results

Variable	Sig.	Significance value of Two Side P
Learning Outcome	0.028	<,001

Based on the conditions used in decision-making in the t-test, the significance < 0.05 shows that there is a significant difference after being treated in the sample class. Table 2 shows that the Significance value of Two Side P < 0.001 which means that the significance value of the analysis results is below 0.05. These results show that the treatment given in the Experimental Class, namely Cooperative Problem Solving learning with the science process skills approach, is effective in providing a significant difference.

The results of data analysis Observation of aspects of science process skills in two sample classes using observation sheets of science process skills which include aspects of observing, analyzing, hypothesizing, and communicating have shown that students in the experimental class are more active in observing, analyzing data, hypothesizing, and communicating on the subject of simple harmonic motion compared to students in the control class. The results of the analysis of student science process skills observation data are presented in the following Table 3.

Table 3. Results of science process skills observation data analysis

No	SPS Aspects	Average science process skills aspects	
		Experimental Classes	Control Classes
1	Observe	2,69	2,47
2	Analyze	2,94	2,25
3	Hypothetizing	3,09	2,19
4	Communicate	3,00	2,47
	Average	2,93	2,34

Table 3 above shows that the average value of the SPS aspect in the experimental class and the control class also differed. The average score of the SPS aspect in the experimental class was higher than in the control class. This result was due to the difference in the treatment given in the two sample classes, where in the experimental class used Cooperative Problem Solving learning with the Science Process Skills approach while in the control class used conventional learning that teachers usually apply in schools. Learning in the control class that does not stimulate the activeness of students is the cause of students' low science process skills, plus students are uncooperative in solving a problem on the subject of simple harmonic motion.

Furthermore, in the data analysis from the questionnaire of students' responses to the learning given, it is known that most students give positive responses to cooperative problem solving learning with the science process skills approach. Students feel that they understand the simple harmonic motion concept better through direct discussion and exploration. The results of the analysis of student response data in the two sample classes can be seen in Table 2 below.

Table 4. Results of Students' Responses to Learning

No	Class	Average Student Response for each question							Average
		1	2	3	4	5	6	7	
1	Experiment	2,69	2,94	3,09	3,00	2,88	2,94	2,50	2,86
2	Control	2,47	2,25	2,19	2,47	2,22	2,28	2,28	2,31

The results of the analysis of student responses in Table 2 show the average value of students' responses to 7 questions about their responses to the learning given in the experimental class and the control class. The average response score of students in the experimental class was higher than the average response of students in the control class. This shows that students give a positive response about learning cooperative problem solving with the science process skills approach on the subject of simple harmonic motion. students' attitudes towards the creative problem solving learning model are positive [32].

Creative problem solving learning with the science process skills approach has proven to be effective because it combines group cooperation and scientific exploration. Students can associate theory with practice, so that the understanding of concepts becomes more deep. The results of this study are in line with the constructivist learning theory which emphasizes the importance of social interaction and active involvement of students in the learning process. The concept construction process is based on the process skills possessed by the learners [20].

This study is unique in integrating the Cooperative Problem Solving (CPS) approach with Science Process Skills (SPS) in physics learning, especially in Simple Harmonic Motion (GHS) material. This combination has not been widely applied in depth, especially at the secondary education level, although both approaches have proven effective in increasing student engagement, conceptual understanding, and scientific thinking skills. This study provides innovation by showing that the application of CPS-SPS can create a more interactive learning experience, hone students' scientific skills, and facilitate the transfer of physics concepts to real-life contexts.

The results of this study provide important implications for the world of education, especially in physics learning. The CPS approach supported by SPS has been proven to be effective in improving students' understanding of GHS concepts and scientific skills such as observation, data analysis, and problem solving. Teachers are expected to be able to adapt this approach to other physics topics in order to improve overall student learning outcomes. In addition, this study also encourages the development of teacher training programs to be able to apply learning strategies based on collaboration and scientific exploration optimally in the classroom.

4. CONCLUSION

Learning cooperative problem solving with the science process skills approach is effective in improving the understanding of the concept of simple harmonic motion. Students are not only able to master theory, but also develop scientific skills such as observation, data analysis, and problem-solving. This approach can be adapted to other physics topics. Teachers need to be trained to implement the cooperative problem solving with the science process skills strategy optimally. Further research is suggested to explore the impact of this approach on higher-order thinking skills.

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