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Physics Teaching Materials Based on The Creative Problem-Solving Model with Concept Maps: The Effect on Students' Learning Outcomes

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Abstract: This motivation research is the low learning outcomes of physics students at SMA Pertiwi 1 Padang. The process of learning es the teacher does not activate students in finding solutions to problems in elasticity and static fluid material and the materials for teaching used that do not support the model of learning chosen by the teacher. The research type conducted was a quasi experiment using the Randomized Posttest Only Control Group Design. Purposive Sampling was used as a technique. Around 37 and 34 students involved in this study as experiment and class for control respectively. Data obtained from a test with multiple choice questions. Based on data analysis, the average physics outcomes of learning from students in the knowledge aspect in the in class for experimental is 82 which higher than the class for control which is 76. Hypothesis testing of the posttest conducted $t_c > t_t$ where $1.831 > 1.666$ H_0 is rejected and H_1 is accepted, the conclusion is the research results that the use of physics material for teaching based on the creative problem-solving model with concept maps has a effect in significant on the outcomes of learning from students in class XI MIPA SMA Pertiwi 1 Padang on the knowledge aspect with a real level of 0.05.

Keywords: Concept Map; Creative Problem-Solving Model; Physics Learning Outcomes; Teaching Materials

Introduction

In the 21st century, education is increasingly oriented towards the various skills that students must master. The 21st century is a time of rapid technological and scientific development (Arini & Juliadi, 2018). According to Law No. 20 of 2003, education is a planned effort to obtain a process of learning and atmosphere for students can be active to explore and build their potential through learning. The part of the efforts made from government to advance the education world is to improve the system of education by implementing the 2013 curriculum.

Curriculum 2013 is a new education system that requires students and teachers to change the way of teach and learn. As stated in Permendikbud No. 22 of 2013, so that the process of learning is organized can be interactive, inspiring, happy, give challenge, motivation for students to give active participation, and allowing pupils enough room for initiative, creativity, and independence in relevan with their talents, interests, and physical and psychological growth. It is envisaged that by implementing the 2013 curriculum in learning, students who are energetic, creative, productive, innovative, and have character will be produced.

Learning is a two-way interaction between a teacher and a pupil in which intense and directed communication (transfer) is directed toward a predetermined target (Trianto, 2012). For learning objectives to be achieved properly, physics learning can be supported by good facilities and infrastructure. One of them is the use of various material for teaching.

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Teaching materials are a collection of learning tools or instruments that contain learning materials, procedures, limitations, and evaluation methods that are deliberately created and appealing in order to meet the intended goals, namely attaining competence or subcompetence in all its complexities (Widodo et al., 2013).

Because of the importance of material for teaching in the process of learning, teachers must be permitted to use material for teaching that are in relevan with student needs and curricular expectations, and are not reliant on textbooks or government-assisted textbooks (Andani & Yulian, 2018). Therefore, The availability of high-quality instructional resources can influence motivation, interest, and creativity, resulting in improved outcomes of learning from student. Teaching materials are very useful for teachers and students. For teachers, material for teaching can be used as a reference or guideline regarding the competencies that must be taught in learning. As for students, material for teaching can be used as a guide to find out the competencies that must be mastered in learning (Aisyah et al., 2020). Teachers will struggle to improve the efficacy of their learning if it is not accompanied by comprehensive teaching resources. Similarly, students will struggle to study if they do not have access to educational materials.

Teaching materials are information, tools, and texts required by instructors for lesson planning and evaluation. In the process of learning, there is an assumption that the material presented by the teacher to students will be absorbed directly by students. This is because there are many abstract concepts in science, which are quite difficult for students to understand. Concepts according to Dahar (2011) are mental abstractions that represent a certain class of stimuli. A person is said to have learned a concept if that person can display certain behavioral behaviors. Therefore, when the teacher will explain about certain topics in science, the teacher should choose the right model or method, which can facilitate students in understanding physics concepts. One way that can be used to make it easier for students to understand physics concepts is with concept mapping.

If students can connect previous knowledge information with the new one, then that is said to be meaningful knowledge. According to Dahar (2011) the meaningful learning is learning that relates or connects the information to the knowledge they have. This concept map will help students know the organization of physics concepts. The use of concept maps could facilitate student to think, help strengthen memory and students can connect important facts which are then described properly and can improve outcomes of learning from students (Hamid et al., 2018).

Learning outcomes are a level of student success in learning that will be expressed by the value obtained through a test of the subject matter. Learning outcomes are one indicator of the process of learning which includes three aspects: attitudes, knowledge, and skills (Susanto, 2016). The importance of studying physics for students includes helping students solve real-life problems related to physics and being able to prove the truth of a theory or concept that has existed before. Physics always prioritizes concepts so that from there a certain mathematical formula is obtained.

In the physics process of learning, the use of material for teaching and innovative model of learning is very important to support the success of the model of learning used to improve student outcomes of learning (Purnamasari & Lestari, 2017). Teaching materials must be relevant to the model of learning used in activities of learning so that students are able to achieve the expected outcomes of learning in learning. If a teacher collaborates models and media well in learning, the process of learning quality will improve as well as improving outcomes of learning from students as a reflection of the success of education (Yusuf, 2017).

Based on observations made at SMA Pertiwi 1 Padang, it was found that the outcomes of learning from high school students in physics were still relatively low. This is because in the existing material for teaching at school there is no innovative model of learning that is in relevan with the characteristics of physics learning. In the case of low student outcomes of learning, teachers still teach with teacher-centered learning. The implementation of the teaching method from the teacher is apparently not enough to significantly improve outcomes of learning from students in physics according to the data on the end-of-semester assessment results which are still very far from expected.

The implementation of CPS learning can improve physics outcomes of learning and student activities of learning (Hikmah, 2009). Familiarizing students in finding their own answers to the problems raised can improve students' understanding of concepts and communication skills in physics learning. The Creative Problem Solving learning is a model of learning that emphasizes instruction and problem-solving skills, followed by skill building (Effendi & Fatimah, 2019).

The CPS is a model of learning centered on skills of problem solving followed by creative reinforcement. CPS is a problem solving learning variation by using systematic technical problem solving in organizing creative ideas to fix a problem (Rahmatin et al., 2019). The CPS model has several stages that students must go through during the process of learning which include clarification of problem, opinion expression, evaluation and selection, and implementation (Pepkin, 2004).

Activities of learning in the classroom are not only listening and taking notes, students are trained to discuss, express opinions, foster self-confidence, and develop creative thinking skills, so that students in groups can use various ways creatively to solve problems (Mayasari et al., 2013).

The selection of the Creative Problem Solving model of learning in the process of learning is because it can train students in designing new discoveries, act and think creatively, solve problems faced realistically, identify and conduct investigations, interpret and evaluate the observations results, stimulate the development of students' thinking progress in solving problems at hand, and be able to make school education more meaningful in life, especially in the implementation of field work (Wansaubun, 2020).

Each model of learning has advantages and disadvantages. The advantages of creative problem solving are training students to design a discovery, think and act critically, solve problems faced realistically, identify, and conduct investigations, and stimulate the development of students' thinking progress to solve the problems faced appropriately (Maheva et al., 2023). While the shortcomings of the creative problem solving model of learning are that some subjects are very difficult to implement this model of learning and require a longer time allocation than other model of learning (Shoimin, 2014).

Concept maps contained in material for teaching based on the CPS model can increase student activeness to create more independent learning attitudes. The concept network described in the concept map, learning becomes meaningful because new knowledge or information with structured knowledge that students already have is connected so that it becomes more easily absorbed by students (Wahidi, 2017). Students find it easier to understand between one concept and another.

The physics materials to be discussed in this study are elasticity and static fluid. According to Zani et al. (2018) Some students regard elasticity and Hooke's law, temperature and heat, static fluid, and thermodynamics to be challenging materials in physics since the concepts are difficult to understand. One of the reasons that physics classes are regarded as tough is that the content is difficult to understand since it requires memorization, formulas, and mathematical computations (Junina et al., 2020). Physics material that is complicated, numerous, and difficult to understand, can be overcome or minimized by mapping or planning the material studied, so that students more easily understand the material, and will affect the improvement outcomes of learning from students (Fatimah, 2022).

Based on the problems of low outcomes of learning, the use of material for teaching that have not been equipped with models, and students' difficulties in understanding elasticity and static fluid material. Therefore, researchers want to conduct research by taking the positive side of the use of teaching material based on learning model accompanied by concept maps, so that it can be implemented in the classroom to improve students' learning outcomes.

Method

The method used in this research is the quasi-experimental method. According to Sugiyono (2015) is method has a class for control, However, it is unable to properly regulate external variables that affect the experiment's implementation. The Randomized Posttest Only Control Group design was employed in this research. This design consists of two groups, namely the group for experimental and the group for control with a posttest. Posttest is a test given after activities of learning are conducted, the aim is to determine the extent to which students master the material that has been taught. The in class for experimental was treated with learning using material for teaching based on the CPS model and the class for control with learning treatment using material for teaching from school. In simple terms, this design for research shown in Table 1.

Table 1. Research Design

Class	Treatment	Posttest
Experiment	X	O
Control	-	O

Source: Sugiyono (2015)

The affordable population studied in this research were all students in grade XI MIPA SMA Pertiwi 1 Padang who were enrolled in the odd semester of the 2022/2023 academic year. In this research, sampling was conducted using a purposive sampling. The sample selection was conducted with the consideration of the subject teacher who categorized two classes that were homogeneous and had the same average ability in terms of the daily test assessment results. The two classes were XI MIPA 1 class as the class for experimental and XI MIPA 2 class as the class for control.

The research procedure consists of 3 phases including the planning phase, the implementation, and the completion. The procedure in this research shown Figure 1.

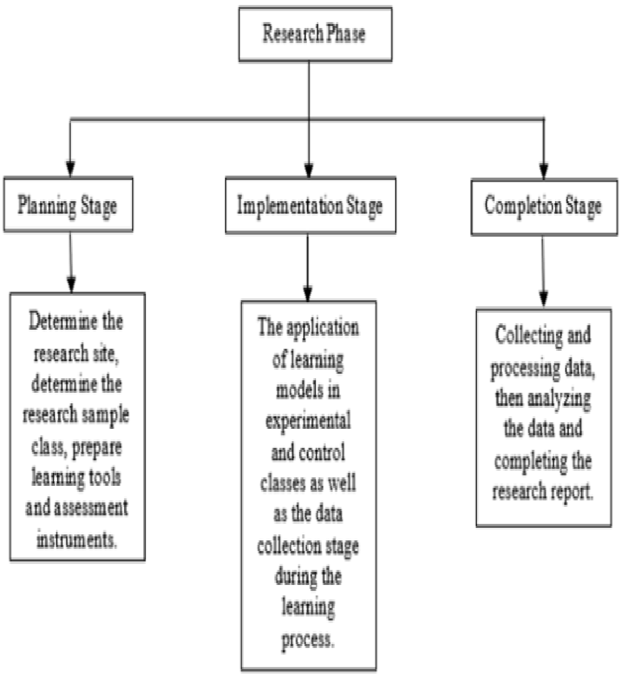

Figure 1. Research Stage

The data in this study are students' physics outcomes of learning on elasticity and static fluid materials. The technique for data collection used the final test questions in the shape of multiple choice as many as 25 questions. The items used in this test have been tested for validity, reliability, difficulty level and differentiation. The technique for data analysis uses test of normality with test of and homogeneity with F test. Data requirements are having distribution in normal if $L_c < L_t$ and the condition that the data has a variance in homogeneous if $F_c < F_t$. After the data is distribution in normal and homogeneous, hypothesis testing is conducted with the t-test to reveal whether H_0 is accepted or rejected. The test condition H_0 is accepted if $t_c < t_t$ and H_0 is rejected if it has another figure at a significant level of 0.05. After processing the data, it is then analyzed and conclusions are drawn in the study.

Result and Discussion

Data on outcomes of learning from students in the knowledge aspect were obtained after the process of learning through written tests in the shape of questions in objective. This test was given to both samples at the end of the research activities. Based on the statistical calculations results, the average value was obtained ($\bar{X}$), standard deviation (S), and variance (S^2) classes for experimental and control as in Table 2.

Table 2 shows the average value of students' physics outcomes of learning in the knowledge aspect of the class for experimental is higher than the class for control. The standard eviation value of the class for experimental is smaller when compared to the standard deviation value of the class for control, meaning that the physics outcomes of learning of the in class for experimental students are more evenly distributed than the class for control. The variance value of the in class for experimental is smaller than the class for control, meaning that the physics outcomes of learning from students in the class for control are more diverse than the in class for experimental.

Table 2. Statistic Description

Class	N	Values		$\bar{X}$	S^2	S
		Max	Min			
Experiment	37	96	40	82	172.97	13.152
Control	34	96	40	76	209.23	14.456

Data analysis was conducted to see whether the average difference between the two sample classes was significant or not. Before drawing conclusions from the research results, data analysis was conducted through statistical hypothesis testing. Hypothesis testing is done to find out whether the hypothesis is accepted or rejected. The steps taken in hypothesis testing are through test of normality and homogeneity of both sample classes first, then hypothesis testing is conducted.

The test of normality was conducted to see whether the class came from a normal population or not using the Liliefors test. The significance used $\alpha = 0.05$ and the result showed in Table 3.

Table 3. Result of Normality Test

Class	α	N	L_c	L_t	Info
Experiment	0.05	37	0.1408	0.1457	Normal
Control		34	0.1033	0.1519	Normal

Table 3 shows that all sample classes have a value of $L_c < L_t$ at significance of 0.05, it means that the data from the final test two sample classes results are distribution in normal. After the normality test is conducted, then the test of homogeneity is conducted to see the variance of the data of the two classes. The homogeneity test results shown in Table 4.

Table 4. Results of Homogeneity Test

Class	α	N	F_c	F_t	Info
Experiment	0.05	37	1.02096	1.2734	Homogen
Control		34			

Table 4 shows that the homogeneity test results on the final test data of the two sample classes. It was obtained F_c = 1.2096 and F_t with a real level of 0.05. The results show $F_c < F_t$, this means that the data of the two sample classes have a homogeneous variance.

After conducting normality and homogeneity tests on the final test data of the two sample classes, it was found that the data in the two sample classes were have distribution in normal and had variances in homogeneous. Then hypothesis testing was conducted to determine whether the hypothesis was accepted or rejected using t-test. The result is shown in Table 5.

Table 5. Result of T-test

Class	1-α	N	$\bar{X}$	T_c	t_t
Experiment	0.95	37	82	1.831	1.666
Control		34	76		

Table 5 shows that t_c = 1.831 while t_t = 1.666 with testing criteria H_0 is accepted if $t_c < t_t$ and H_0 is rejected if it has another price at a significant level of 0.05. Because the price of t_c is not in the H_0 acceptance area, it is concluded that H_1 is accepted at a real level of 0.05. Based on the statistical analysis conducted from the data, there is a significant positive effect on the application of material for teaching based on the CPS model with concept maps in the knowledge aspect. The acceptance and rejection curves of the null hypothesis shown in Figure 2.

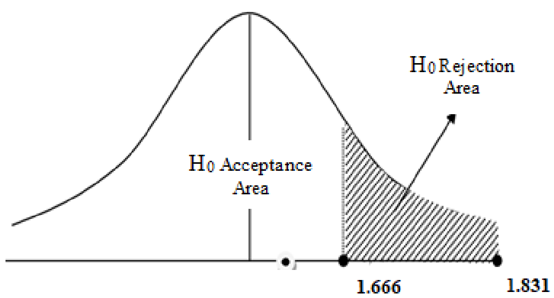

Figure 2. Acceptance and Rejection Curves of the Null Hypothesis

Based on Figure 2, the hypothesis acceptance curve in the knowledge aspect shows that t_h is in the H_0 rejection area, which means that the difference in treatment in the two sample classes has an effect. This means that there is a significant effect of using material for teaching based on the CPS model with concept maps on the physics outcomes of learning from students in class XI MIPA SMA Pertiwi 1 Padang in the knowledge aspect.

The research was conducted at SMA Pertiwi 1 Padang, namely classes XI MIPA 1 and XI MIPA 2. The in class for experimental used material for teaching based on the Creative Problem-solving model with concept maps while the class for control used material for teaching from school, namely worksheet. In the in class for experimental, the process of learning was given material for teaching containing student worksheet based on the creative problem-solving model with concept maps at each meeting. When filling out the student worksheet, students seemed confused because they had never been given a student worksheet based on the creative problem-solving model. So that it causes many students to ask questions, this makes researchers feel overwhelmed in dealing with the situation. However, this can be overcome by providing further instructions or explanations on how to fill in the student worksheet contained in the material for teaching, then the researcher gives time for them to discuss with their respective group friends. If there are still questions, the researcher will direct each group and help so that slowly students can understand it well. The student worksheet contained in the teaching material helps students to find a new concept to solve a problem. Where in the student worksheet there are stages that help students to solve a problem so that it can improve outcomes of learning from students (Nurulwati, 2020).

Figure 3. Student present the results of group discussions

Based on research (Budiana et al., 2013) it is explained that CPS learning makes students more active in learning and teachers only act as facilitators and mediators in learning. Students actively carry out the process of learning starting from finding solutions to problems, group discussions, and presentation of discussion results. As stated by Cahyono (2009) which states that the teacher presents the material and students work in groups, at the objective finding stage students examine the problems in the worksheets on material for teaching to be solved in their groups and at the fact finding stage the teacher directs students to find answers to the given problem solving, the problem finding stage students discuss the problems given and the idea finding stage each member in the group brings up his ideas to solve the given problem, then the solution finding stage students choose the best and right idea to use in solving the problem, and finally at the acceptance finding stage that the ideas chosen by students are then used to answer the problem. After students answer the various stages of the creative problem-solving model, students are presented with an empty concept map to fill in by connecting one concept to another. All activities conducted by students have a positive impact in improving outcomes of learning from students (Simanjuntak et al., 2019).

The researcher in this case tried to make all students actively involved in group discussions by providing opportunities for each student in turn to express their respective opinions from the previous group discussion results. Then the researcher will give a reward with a plus for students who are involved in the discussion, so with these students become motivated to be more involved in the implementation of the discussion. Over time there was an increase at each meeting. The next meeting students are getting used to the application of material for teaching based on the creative problem-solving model with concept maps where this teaching material requires students to be actively involved in the process of learning. Students have begun to be able to discuss in their respective groups and begin to respond and give conclusions on learning at each meeting so that learning becomes more meaningful (Ramadhani, 2022).

The observations student activity results in class for experimental conducted using material for teaching based on the creative problem-solving model show that students look more interested in participating in learning, because in this class it is very visible how many students pay attention to the teacher's explanation. In addition, students become more active during learning and can express opinions or ideas to solve problems given by the teacher. This is as expressed by (Treffinger, 2013) that one of the advantages of the CPS model is that it makes students act actively in learning and trains critical and creative thinking, because it presents problems at the beginning and gives students the freedom to look for directions for solutions.

This assessment includes physics outcomes of learning in the knowledge aspect. For the assessment of physics outcomes of learning in the knowledge aspect is done by holding a posttest. Before conducting the posttest, the questions given were tested first at a different school with the sample and normality test, reliability test, differentiability and difficulty level were conducted so that 25 questions were obtained which would be used for the posttest questions of the two sample classes.

The analysis results obtained from the posttest results are different. Based on the analysis results, it shows that the average value of students in the in class for experimental is higher than the class for control. Where the in class for experimental itself uses material for teaching based on the creative problem-solving model so that students' interest in learning increases and has an impact on student outcomes of learning and fosters critical ideas to solve problems during learning. If you review the student scores on the daily learning test scores, there is an increase in the average in both sample classes when compared to the initial data of the sample, indicating that the growth of learning motivation for students. This is in relevan with research Paradina et al (2019), who stated in his research that there was an effect of learning using material for teaching based on the creative problem solving model on student physics outcomes of learning. Depdiknas (2008) also states that the advantage of worksheets for students is that students will learn independently, learn to understand, and carry out a written task. This causes students' physics outcomes of learning to increase.

The use of material for teaching based on the creative problem-solving model can train students to be more active in learning, so that students do not only act as objects of learning, but also play an active role in carrying out many activities. In addition, the application of learning using material for teaching based on creative problem-solving models with concept maps provides new experiences for students in learning physics, especially in elasticity and static fluid materials. In addition, at the learning stage students are more trained to be able to formulate problems appropriately and what facts appear in the problem so that students can explore their ideas in formulating problems. Get solutions in problem solving and trained to understand complex problems.

Students are interested in the activities conducted during the process of learning, with the problems given by the teacher making students challenged to solve these problems. Students with their groups try their best in solving the problems given by the teacher because they want to succeed in solving these problems. According to Hasanah et al (2021) This learning approach requires students to take an active role in non-teacher-centered activities of learning in order to improve outcomes of learning from students on the subject matter taught. This type of process of learning necessitates that students take an active role in activities of learning that are not just focused on the teacher in order to increase student learning results on the subject matter given (Djonomiarjo, 2020).

In the class for control using material for teaching from school, namely worksheet, this learning is conducted by students being asked to observe the teacher's explanation. After that students take notes on what the teacher says, after the teacher explains the material, the teacher gives students questions about problems in the surrounding environment, only a few students want to answer. After that, students are asked to do exercise questions related to the material that has been given. Some students seemed to pay less attention to the teacher who was explaining the material, seemed busy with their friends, and did not understand the exercises given by the teacher.

From this explanation, the use of material for teaching based on the creative problem-solving model has a better effect in developing outcomes of learning from students on elasticity and static fluid material than using LKS from school. Learning in class for experimental with material for teaching based on model of creative problem-solving learning is more fun because in learning there is group cooperation. While in the class for control that uses worksheets from school students play less role in learning, learning is more dominated by the teacher. The difference in student outcomes of learning in Physics subjects arises because of the different treatment between the class for control and the in class for experimental.

When conducting research using material for teaching based on the creative problem-solving model, researchers experienced several obstacles. The first obstacle, students who are not accustomed to learning using material for teaching based on creative problem-solving models. During the process of learning, it is expected that all students are active in activities of learning and find their own solutions to existing problems. However, in reality there are still students who do not understand the steps of material for teaching based on the creative problem-solving model with concept maps. To overcome this obstacle, teachers are expected to explain the definition and steps of the creative problem-solving model before the process of learning.

The second obstacle is that when carrying out experiments it is difficult to control the time and all student activities because students feel interested and curious about the experimental tools that will be used. To overcome this, at the time of the experiment activities tried to supervise students closely, so that the time to carry out the experiment can be used effectively and efficiently.

The third obstacle, there are still some students who do not read and understand the objectives of the activities and learning objectives in the material for teaching based on the creative problem-solving model, so they do not understand the subject matter and activities of learning contained in the material for teaching. To overcome this, teachers try to guide students and remind them to read material for teaching properly and correctly. The last obstacle, namely learning takes a long time, the purpose of forming groups has not been maximized where students tend to discuss things outside the learning material if not supervised, and some students experience obstacles in finding ideas for problem solutions due to lack of learning resources, limited laboratory equipment and inadequate school facilities. From the various obstacles faced, the researchers suggest that before starting learning students need to prepare various kinds of learning resources and learning media such as the tools used to do practicum so as not to reduce the effective time of learning and it is hoped that further research on physics material can use material for teaching based on creative problem-solving models with concept maps with a wider and more complex space.

Conclusion

Based on the research results and data analysis that has been conducted, it can be concluded that the application of physics material for teaching based on the creative problem-solving model with concept maps can have a significant effect on the outcomes of learning from students in class XI MIPA in the physics subject matter of elasticity and static fluid. This is indicated by the value of t_c = 1.831 while t_t = 1.666. Thus it is known that $t_c > t_t$ is 1.831> 1.666 which means H_1 is accepted and H_0 is rejected. This shows that there is a significant effect of using physics material for teaching based on the creative problem-solving model with concept maps on the outcomes of learning from students in class XI MIPA SMA Pertiwi 1 Padang.

Author Contributions

All authors have contribution to the completion of this manuscript. V.N.P has contribution in conducting research, while P.D.S reviewed the manuscript, H.H and S.Y.S validated the papers used.

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Conflicts of Interest

There is no conflict of interest.

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