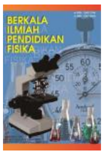

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The C3PDR Learning Model to Increase Conceptual Understanding and Creative Thinking Skills of Senior High School Students

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Abstract

The C3PDR Learning Model was designed to increase student creativity in science. This study aimed to determine the effect of C3PDR learning model on improving conceptual understanding and creative thinking skills of senior high school students on sound waves topic. This study used a Quasi-Experimental Method and One-Group Pretest-Posttest Design. The sample in this study was 32 students of the eleventh-grade student in the 2017/2018 academic year from one of senior high school in Samarinda, selected by purposive sampling. Data collection used Test Techniques. The instrument used Essay Questions. Essay questions indicators to determine the understanding of physics concepts were interpreting, clarifying, comparing, summarizing, and inferring. Essay questions indicators to determine students' creative thinking skills were Asking Questions, Guessing the Causes, Guessing the Cause of an Occurence or Even, Improving product, and Supposing. Analysis of the data used is the N-Gain analysis and paired t-test. The results showed the C3PDR Learning Model influenced the increase of conceptual understanding and the creative thinking skills of senior high school students on sound waves topic. This is indicated by 1) N-Gain of conceptual understanding was 0,76 in the high category, 2) N-Gain of creative thinking skills was 0.51 in the moderate category, 3) A significant difference between students' conceptual understanding and 4) the students' creative thinking skills before and after the C3PDR Learning Model was applied, marked with p mode <0.05.

Keywords: C3PDR learning model; conceptual understanding; creative thinking skills

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INTRODUCTION

Based on the Framework of 21st century learning, one of the skills that students need to have is creative thinking skills which are part of learning and innovation skills (Council, 2011). Students need to have creative thinking skills, so they are ready to face a complex and fast-changing world (Gu, Dijksterhuis, & Ritter, 2019). The attention of researchers in the field of research related to creativity is a reasonable thing because many benefits of creativity that can be obtained both for individuals and society (Bereczki & Karpati, 2018). Indonesia explicitly includes creativity as one of the competencies of the competency standards for primary and secondary school graduates.

Learning that can increase students' mastery of knowledge does not automatically improve students' creative thinking skills. Mastery of knowledge contributes 30% to creativity (Zulkarnaen, Supardi & Jatmiko, 2018). Learning that increases knowledge, as well as creative thinking skills, needs to be developed. Several studies have been carried out related to various strategies, models or methods used to improve creative thinking skills, including using: the Learning to Think (LTT) (Hu et al., 2013), U-CCPS learning activities (Laisema & Wannapiroon, 2014), Project Creative Learning (PCL) model (Wibowo, Suhandi, & Harjoto, 2013), Student Facilitator and Explaining (SFAE) model (Malik, Nuraeni, Achmad Samsudin, & Sutarno, 2019), Ethnoscience Learning (Khoiri, Nulngafan, W., & Sajidan, 2019), 5I Training Program (Gu, Dijksterhuis & Ritter, 2019), Pogil Learning Model (Pratiwi, Ashadi, & Harjunowibowo, 2019), through interactive multimedia (Hakim, Liliasari, & Saptawati, 2017), Guided Inquiry Learning model (Zaky, Darmadi, Jarnawi, & Musdalifa, 2019), Creativity Responsibility Based Learning (Suyidno et al., 2019), Problem Based Learning Model (Nulhakim, Setiawan, & Saefullah, 2020; Wartono, Diantoro, & Bartlolona, 2018), and C3PDR model (Zulkarnaen, Supardi, & Jatmiko, 2017).

In connection with these studies, tests of creative thinking skills have been developed, both general and specific in certain fields. Commonly accepted critical thinking skills tests include The Torrance Tests of Creative Thinking (TTCT) (Torrance, 1966), the Creative Scientific Ability Test (C-SAT) (Ayas & Sak, 2014) and Remote Associates Test (RAT) (Mednick & Mednick, 1971). The test of creative thinking skills in physics is mostly developed by researchers based on keywords in creative thinking, namely fluency, flexibility, originality and elaboration, which are adjusted to the material discussed.

The test of the creative thinking skills used in this study is a test developed by Alrubaie & Daniel (2014). The test is a refinement of the creative thinking skills test of some previous researchers namely "The Torrance Test of Creative Thinking (TTCT)" developed by Torrance (Alrubaie & Daniel, 2014), a creative thinking skills test that refers to the Scientific Creativity Structure Model (SCSM) used by Hu

& Adey (Hu & Adey, 2002), Scientific Process Skills and Scientific Creativity developed by Pekmez, Aktamıs, & Taskın (2009). The creative thinking skills test developed by Alrubaie & Daniel (2014) showed a change in students' mindset after the learning process. The test can measure creative skills in students where: students will be confronted with a picture and from the picture students will make as many questions (asking questions), guessing the cause, guessing the effect (guessing the reason of an occurrence or an eval, improving the product, alternative uses of common materials and supposing so that the process of increasing students' creative thinking skills are based on an image that will trigger scientific behaviours that arise from the minds of students.

There are similarities between the creative thinking test developed by Alrubaie & Daniel for the senior high school level and the scientific creativity test developed by Hu and Adey for the junior high school level. Both are developed from the same theory of creativity, namely the Scientific Creativity Structure Model (SCSM) developed by (Hu & Adey, (2002). The scientific creativity test developed by Hu & Adey consists of 1) skilled at developing scientific knowledge creatively, 2) skilled at developing creative experiments, 3) skilled at understanding phenomena, 4) skilled at solving science problems with various creative solutions, 5) skilled at making various creative questions to solve science problems, 6) able to improve the quality of a science product, 7) able to design a new product creatively.

Development of the C3PDR learning model initially focused on increasing the scientific creativity of junior high school students; therefore the authors were interested in implementing the model also at the senior high school level in Physics which is part of science. The C3PDR model is designed to enhance scientific creativity, in which in the learning process, students practice creative thinking skills. The syntax of the C3PDR model is: the first phase is Creative exploration, the second phase is Creative elaboration, the third phase is creative modelling, the fourth phase is scientific creativity practice, the fifth phase is a discussion, and the sixth phase is reflection.

This study was to prove that the C3PDR model was able to improve creative thinking skills in senior high school students significantly. The benefit of this research is to provide an alternative learning model that can improve creative thinking skills.

METHODS

This study used a quasi-experimental method, and the research design used was one-group pretest-posttest design. In this research design, the tests were carried out twice, namely before and after the treatment. The treatment given is in the form of a learning process using the C3PDR model on sound waves topic. C3PDR learning applied in this study has learning steps consisting of Creative exploration, Creative elaboration, Creative modelling, Practice scientific creativity, Discussion and Reflection.

The study was conducted in the even semester of the 2017/2018 academic year. The study population was all students of eleventh grade in one of senior high school, Samarinda, East Kalimantan, Indonesia. The sampling technique used purposive sampling, and selected samples were 32 students of the eleventh-grade student at the school. Sample selection is a recommendation given by the physics teacher who teaches at the school because students in this class have the same average cognitive abilities.

Data collection techniques for students' conceptual understanding and creative thinking skills using test techniques. The research instrument to capture the data of students' conceptual understanding was essay questions in the sound waves topic, as many as five questions, refers to the conceptual understanding indicators consisting of interpretation, clarifying, comparing, summarizing, and concluding. The instrument for capturing data on students' creative thinking skills consists of six essay questions on sound waves topic with indicators of creative thinking skills consisting of asking questions, improving products, proposing causes, guessing the consequences, and positioning.

Analysis of the data used in this study is the analysis of the average value of students' understanding of concepts and creative thinking skills, frequency distribution, N-Gain, and T-Test. The frequency distribution is used to classify student scores that are converted into percentages into several categories, with the following criteria: not good category if the student scores are in the range of $0 \leq x \leq 50$; less good category if the students' grade is in the range of $50 \leq x \leq 60$; good enough category if the students' grade is in the range of $60 \leq x \leq 70$; good category if the studens' score is in the range of $70 \leq x \leq 80$, and excellent category if the students' value is in the range of $80 \leq x \leq 100$ (Arikunto, 2012). Data analysis techniques to find out the increase in understanding of concepts and creative thinking skills of students was N-gain analysis. The N-Gain criteria used are as follows: low category if N-gain $\leq$ 30; moderate category if 0.30 <N-Gain $\leq$ 70; and high category if N-gain> 0.70 (Meltzer, 2002).

The presence of significant differences between the results of the students' understanding of concept tests and creative thinking skills before and after the application of the C3PDR learning model to the sound waves topic were analyzed through hypothesis testing namely paired t-test. Testing through the t-test is to compare t arithmetic with tables at the real level $\alpha = 0.05$. The t-test has a positive and significant effect if the results of the calculation of t arithmetic are greater than t table (t-count> t-table) or the probability of error is less than 5% ($p < 0.05$).

The hypotheses used in this study include the following:

Ha_1: There is a significant difference between senior high school student's conceptual understanding of sound waves topic before and after the C3PDR learning model is applied.

Ha2: There is a significant difference between senior high school student's creative thinking skills on sound waves topic before and after the C3PDR learning model is applied.

RESULTS AND DISCUSSION

In this section will be presented results and discussion of research following the research objectives that have been formulated, including:

1. The Increase of Conceptual Understanding on Sound Waves Topic

The lowest, highest, average, and frequency distribution of students' conceptual understanding based on pre-test and post-test data can be seen in Table 1.

Table 1 Value and categories of students' conceptual understanding based on pre test and post test data

No	Students' Conceptual Understanding	Pre Test	Post Test
1	Number of Students	32 students	32 students
2	Lowest Value	6.7	67
3	Highest Value	60	100
4	Scores an average of	31.32	83.84
5	Frequency Distribution:		
	a. Not Good	81.25%	0%
	b. Less Good	15,625%	0%
	c. Good Enough	3..125%	12.5%
	d. Good	0%	3,125%
	e. Excellent	0%	84.375%

Based on Table 1, there was an increase in students' conceptual understanding before and after the C3PDR learning model was applied. Before the C3PDR learning model was applied, there were no students who had a conceptual understanding of the good and excellent category, more than 80% of students were in the category of not good. After applying the C3PDR learning model, more than 80% of students were able to reach the excellent category, and there were no more students with a less good or not good conceptual understanding.

The average value of N-Gain for students' conceptual understanding obtained a score of 0.76, which is included in the high category. The percentage of students who had N-Gain in the low, moderate, and high categories can be seen in Figure 1.

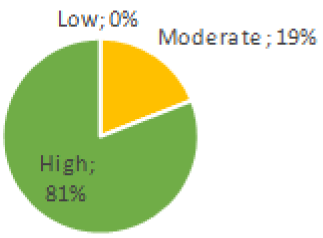

Figure 1 Percentage of students in each conceptual understanding n-gain category

Based on Figure 1, the C3PDR learning model effectively improves student's conceptual understanding, up to more than 80% of students are in the high category, and there was no students are in the low category. The comparison of student's pre test and post test values for each conceptual understanding indicator can be seen in Figure 2.

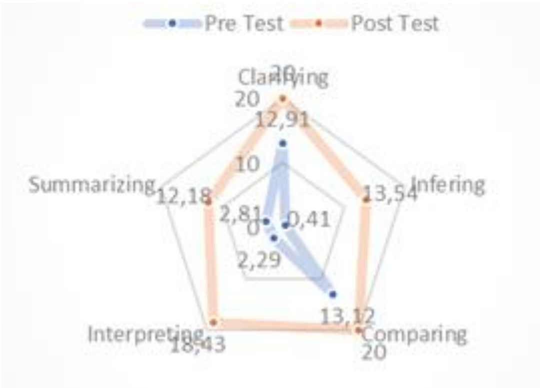

Figure 2 Comparison of student's pre test and post test conceptual understanding

Figure 2 shows that there is an increase in each indicator of conceptual understanding. Pretest results data show the highest average value of students on the clarifying indicator and the lowest on the inferring indicator. After applying the C3PDR learning model, the Post Test result data shows the highest average scores of students on the clarifying and comparing indicators while the lowest on the summarizing indicator.

The comparison of students' average N-Gain on each conceptual understanding indicator can be seen in the following Table 2.

Table 2 The average of n-gain and category for each conceptual understanding indicator

Indicator	**N-Gain**	**Category**
Clarifying	1	High
Infering	0.67	Moderate
Comparing	1	High
Interpreting	0.91	High
Summarizing	0.54	Moderate

Table 2 shows that the highest increase in students' understanding of concepts is on the clarifying and comparing indicator, while the lowest on the interpreting indicator.

2. The Increase of Students 'Creative Thinking Skills on Sound Waves Topic

The lowest, highest, average, and frequency distribution of students' creative thinking skills based on pre-test and post-test data can be seen in Table 3.

Table 3 Value and categories of student's creative thinking skills based on pre-test data and post test

No	**Creative Thinking Skills**	**Pre Test**	**Post Test**
1	Number of Students	32 students	32 students
2	Lowest Value	12	34
3	Highest Value	49	85
4	Average score	26.125	54.90
5	Frequency Distribution:		
	a. Not Good	100%	43.75%
	b. Less	0%	18.75%
	c. Enough	0%	15,625%
	d. Good	0%	12.5%
	e. Excellent	0%	9,375%

Table 3 shows that there was an increase in students' creative thinking skills before and after the C3PDR learning model was applied. Before the C3PDR learning model was applied, all students had not good creative thinking skills. After applying the C3PDR learning model, the percentage of students with not good creative thinking skills has decreased, and even some students have increased their creative thinking skills to excellent category.

The average value of students' creative thinking skills N-Gain obtained a score of 0.51, which is included in the moderate category. The percentage of students who obtained creative thinking skills N-Gain in the low, moderate, and high improvement categories can be seen in Figure 3.

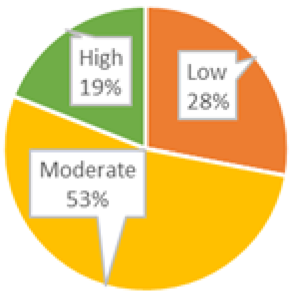

Figure 3 Percentage of students in each n-gain category creative thinking skills

Figure 3 shows that the C3PDR learning model is effective to improve students' creative thinking skills so that the majority of students are at moderate improvement category and the minority.

The comparison of student's pre-test and post-test scores on each indicator of creative thinking skills is shown in Figure 4.

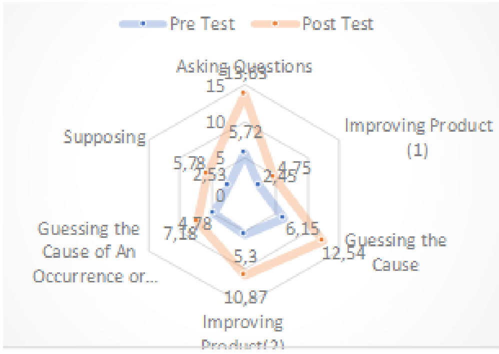

Figure 4 Comparison of pre-test and post-test student's creative thinking skills

Figure 4 shows that there is an increase in each indicator of creative thinking skills. Pretest result data shows the highest average score of students on the Guessing the Cause Indicator and the lowest on the Improving Products (1) Indicator. After applying the C3PDR learning model, Post Test result data shows the highest average score of students on the asking questions indicator while the lowest on the indicator of improving the product (1).

The comparison of the N-Gain average of students on each indicator of creative thinking skills can be seen in Table 4.

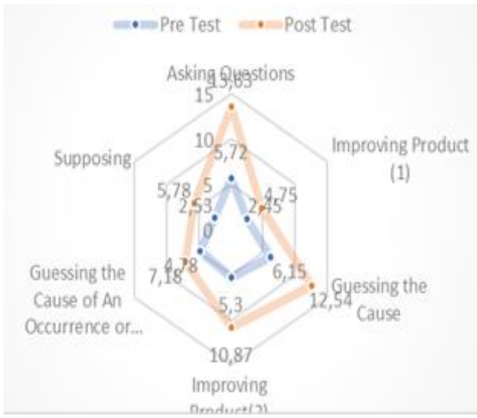

Figure 4 Comparison of pre-test and post-test student's creative thinking skills

Figure 4 shows that there is an increase in each indicator of creative thinking skills. Pretest result data shows the highest average score of students on the guessing the cause indicator and the lowest on the improving products (1) Indicator. After applying the C3PDR learning model, Post Test result data shows the highest average score of students on the asking questions indicator while the lowest on the indicator of improving the product (1).

The comparison of the N-Gain average of students on each Indicator of creative thinking skills can be seen in Table 4.

Table 4 N-Gain average and categories of each creative thinking skills indicators

Indicators	**N-Gain**	**Category**
Asking Questions	0.55	Moderate
Improving Product (1)	0.13	Low
Guessing the Cause	0.46	Moderate
Improving Product(2)	0.37	Moderate
Guessing the Cause of An Occurrence or Even	0.15	Low
Supposing	0.18	Low

Table 4 shows that the highest increase of students' creative thinking skills is the indicator of asking questions, while the lowest on the indicator of improving the product (1).

3. The difference in Student's Conceptual Understanding Before and After C3PDR Learning Model is applied

T-Test results of student's conceptual understanding before and after C3PDR learning model applied can be seen in Table 5.

Table 5 T-test results of student's conceptual understanding

	Paired Sample Test				
	Mean	Std. Deviation	t	Df	Sig. (2-tailed)
Pretest-posttest	-50.903	19.188	-15.007	31	.000

Based on table 5, it can be seen that a significant value of 0.000 ($p < 0.05$) means that there are significant differences between pre-test and post-test scores of students understanding of physics concepts after applying the C3PDR learning model.

4. Differences in Students 'Creative Thinking Skills Before and After the C3PDR Learning Model is applied

T-test results students' creative thinking skills before and after the C3PDR learning model is applied can be seen in the following Table 6.

Table 6 T-test results of student's creative thinking skills

	Paired Sample Test				
	Mean	Std. Deviation	t	df	Sig. (2-tailed)
Pretest-posttest	-30.406	13.028	-13.202	31	.000

Based on Table 6 it can be seen that the significant value of 0.000 ($p<0.05$) means that there are significant differences between the pre-test and post-test scores of students' creative thinking skills after applying the C3PDR learning model

Table 5 and Table 6 show that there are significant differences between students' understanding of concepts and creative thinking skills before and after the C3PDR learning model is applied. This means that the C3PDR learning model influences students' understanding of concepts and creative thinking skills. One of the characteristics of the C3PDR learning model is that exploration and elaboration are believed to be one of the components that play an important role in improving students' understanding of concepts and creative thinking skills.

Hooijdonk, Mainhard, Kroesbergen, and Tartwijk (van Hooijdonk, Mainhard, Kroesbergen, & van Tartwijk, 2020) state that the exploration of knowledge seems to be positively related to the number of ideas that can be raised by someone. Exploration and elaboration activities in the C3PDR learning model can facilitate students to explore and deepen the knowledge they have. By building ideas and discovering interrelated relationships, students can better understand sound wave topic. This is shown explicitly in Table 2, where each indicator of students' understanding of concepts has increased in the moderate and high categories.

Student activities contained in the creative exploration phase in the C3PDR learning model train students' divergent thinking skills. Training in divergent thinking skills is an approach that can increase creativity (Sun, Wang, & Wegerif, 2020). One of the activities of students in this phase is that students are asked to write concepts, terms, or theories that students think are related to the topic of sound waves. This activity accustoms students to use Lotus Blossom thinking techniques. Lotus Blossom thinking techniques have an easy step to do, namely in the form of the process of generating ideas that relate to the main problem. Lotus Blossom thinking technique is one technique that can add focus and strength to classical brainstorming which is believed to be useful for thinking creatively (Hassan, 2018).

Brainstorming techniques and lotus blossom are also used in the practical phase of science creativity. At the practical stage of science creativity, creative thinking techniques used are asked questions, reversal problems, attribute listings, brainstorming, lotus blossom, and synectic Students together with a group of friends work together to solve the problems on the worksheet by making direct observations. Students individually are directed to come up with their ideas first before being incorporated into group ideas. Each student can give input in the group based on opinions, points of view, and ideas they have found before. This activity aims to enable individual students in their groups to actively participate in expressing their ideas and opinions. This process is expected to make students think creatively so that they can think smoothly, flexibly, and genuinely in bringing forth ideas and real work that are better and relatively different from those that have existed before. This, following the statements of Marcos, Ferandez, Gonzalez, and Philips-Silver (Marcos, Fernández, González, & Phillips-Silver, 2020) which states that the activities of students actively participate, analyze, manipulate, and build different sources of literacy will lead them to generate their ideas.

When students work in groups to complete worksheets, they will encourage them to ask questions and exchange ideas. These interactions can facilitate students in increasing their ability to produce and explore ideas that are considered as the main characteristics of creative thinking. Students' insights become wider because they obtain information from a variety of sources obtained from their group colleagues. A collection of ideas, the results of discussions and work on joint tasks can make them able to improve the product, propose causes and consequences, or position. This is shown in the improvement of students' creative thinking skills listed in Figure 1, Table 1 and 2.

Thus the C3PDR learning model facilitates the creation of a learning environment in the classroom that can make students explore their own ideas, raise questions, share questions in groups, collaborate and make direct observations in each learning process so that it can improve student learning outcomes by understanding concepts and creative thinking skills better than before.

The use of the C3PDR model, not only succeeded in improving the creative thinking skills of junior high school students with an N-Gain of 0.42 (Zulkarnaen et al., 2017), but also could improve senior high school students' creative thinking skills with an N-Gain of 0.51, and both were in the moderate category. The C3PDR model adds an alternative method or learning model that can improve creative thinking skills. Another model is The Student Facilitator And Explaining (SFAE) model with an N-gain of 0.56 (Malik et al., 2019), the POGIL model with an N-gain between 0.56 to 0.60 (Pratiwi et al., 2019), Using multimedia with an N-gain of 0.60 (Hakim et al., 2017), problem based learning model with an N-gain of 0.68 (Wartono et al., 2018) and Project Creative Learning (PCL) model with an N-gain of 0.73) (Wibowo et al., 2013). The amount of improvement in creative thinking skills using these models is all in the moderate category except PCL, which is in the high category.

CONCLUSION

Based on the results of research and data analysis can be concluded that the C3PDR learning model has an effect on improving senior high school students' conceptual understanding and creative thinking skills, on the sound waves topic, characterized by (1) The improvement of conceptual understanding of senior high school students on sound waves topic after applying the C3PDR learning model is in the high category, marked by N-Gain of 0.76; (2) The improvement of the creative thinking skills of senior high school students on sound waves topic after applying the C3PDR learning model is in the moderate category, marked by N-Gain of 0.51; (3) The C3PDR learning model can improve and have a positive influence on senior high school students' conceptual understanding of physics concepts, this is indicated by the results of the t-test probability 0.00> 0.05 which shows that there are significant differences between students' understanding of physics concepts before and after the C3PDR Learning Model is applied; and (4) The C3PDR learning model can improve and positively influence senior high school students' creative thinking skills, this is indicated by the results of the t-test probability 0.00> 0.05 which shows that there are significant differences between students' creative thinking skills before and after the C3PDR Learning Model is applied.

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