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FEASIBILITY OF CREATIVE EXPLORATION, CREATIVE ELABORATION, CREATIVE MODELING, PRACTICE SCIENTIFIC CREATIVITY, DISCUSSION, REFLECTION (C3PDR) TEACHING MODEL TO IMPROVE STUDENTS' SCIENTIFIC CREATIVITY OF JUNIOR HIGH SCHOOL

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Abstract. *Creative exploration, Creative elaboration, Creative modeling, Practice scientific creativity, Discussion and Reflection (C3PDR) teaching model is a model specifically developed to improve the students' scientific creativity of junior high school. This research is aimed to analyze the feasibility of C3PDR model in improving the students' science creativity. The teaching model is considered feasible if it meets the criteria: valid, practical and effective. Ninety-six of the eighth-grade students in Samarinda, Indonesia who attended the science subjects participated in the research during the odd semester in academic year 2015/2016. Its validation was performed by three science education experts through focus group discussions and using validation sheets. The practicality of the model was assessed by 4 teachers using the observation sheets and the effectiveness of the model was determined based on the pre-test post-test of scientific creativity. Scientific creativity measured using Scientific Creativity Structure Model (SCSM) test. The results showed that this model has the content and construct validity in very valid category, practical, and effective with the statistic percentage of agreement R > 85% and n-gain values = .42, and p < .05. Thus, the C3PDR teaching model is feasible to improve the student's scientific creativity of junior high school.*

Keywords: *C3PDR teaching model, scientific creativity, feasible, junior high school.*

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Introduction

The amount of effort that experts have done to enhance creativity proves that it is needed in the 21st century. Various techniques and strategies are used to enhance the scientific creativity. Doron, (2017), used a technique, which is to improve creativity through a program in the form of a series of creative tasks that students must complete through their daily activities with the help of visual media such as television and other game media. A ten-week study followed by 10 to 14-year-olds showed that the students' creativity tests were higher than non-program students. Das, Dewhurst & Gray (2011), using the Arts as a Tool for Learning Across the Curriculum (ATLAC) approach, used art as a medium for each subject to create interdisciplinary learning contexts. The results showed that ATLAC was able to improve the characteristics of creativity, namely intrinsic motivation, confidence, curiosity and flexibility. Meanwhile, Lin, Hu, Adey & Shen (2003), Hu, Wu, Jia, Yi, Duan, Meyer & Kaufman (2013), Poon, Au, Tong & Lau (2014), Lewis & Elavar (2014) and Zahra, Yusuooff & Hasim (2013), used creative thinking techniques to enhance creativity. Lin, Hu, Adey & Shen (2003) developed the Cognitive Acceleration through Science Education (CASE) Program, which is basically aimed at improving intellectual abilities in general to junior high school students, but CASE uses mechanisms to enhance scientific creativity, and creativity of science is also the goal of CASE. Three mechanisms that are believed to enhance creativity in the CASE program are meta-cognition, bridging or transfer, and a conducive learning environment. The results of this research indicate that CASE is able to increase students' scientific creativity significantly at α = 5%. Hu, Wu, Jia, Yi, Duan, Meyer & Kaufman (2013) developed the "Learning to Think (LTT)" program to improve students' thinking skills designed for elementary and junior high school students. The thinking skills in question are concrete thinking, abstract thinking and creative thinking. Activities for creative thinking are only 35.70% of all activities consisting of divergent thinking, brainstorming and breaking the set. His research results show that LTT can improve students' creativity.

Poon, Au, Tong & Lau (2014) conducted a research on 74 junior high school students in a short training program in the form of workshops consisting of 5 stages: group stages, giving fun games, reading some stories and asking questions and ending with practice and presentation. Creative thinking techniques used are SCAMPER (substitute, combine, adapt, modify, magnify, put to other uses, eliminate, and rearrange). The results showed that students understand creativity and increased knowledge and confidence, that are reflected by the creativity they produce. The results of Lewis & Elavar (2014) show that students' creativity in product design is improved after being given creativity training with an integrated approach through project work for 15 weeks, using attribute listing techniques. The results of Zahra, Yusuooff & Hasim 's research (2013), show Brainstorming, Tell Story, Web Links and Role Plays, Checklists have a powerful effect on the creativity of preschoolers.

Currently many countries have incorporated creativity as one of the goals of the school curriculum, not least in the school curriculum in Indonesia. Beginning in the 90s, policymakers from several countries, namely Australia, Canada, Great Britain, Hong Kong, China, Singapore and the Middle East have made policies aimed at developing the creative potential of students as they view such efforts as investments for students and the nation's future (Jackson & Shaw, 2006). Creativity becomes one of the important goals in Curriculum 2013 which is applicable in Indonesia today. Therefore, it is needed, a model of teaching, designed specifically to enhance creativity and not just limited to the training programs described above but something that is integrated into the curriculum.

The results of preliminary research in several junior high schools in Samarinda, Indonesia, show that the scientific creativity of students is still low (Zulkarnaen, Nur & Jatmiko, 2015). The question is what kind of teaching model is feasible to improve the students' scientific creativity?

The results of the analysis and synthesis of some literatures show that creativity will arise if supported by sufficient knowledge in the field, if students have creative thinking skills and have motivation Amabile (1996, 2012), Tekic, Tekic & Todorovic (2015), Huang, Peng, Chen, Tseng & Hsu, (2017). The C3PDR teaching model is designed to refer to the synthesis results. One alternative answer to the question is to develop the C3PDR teaching model to improve the scientific creativity of junior high school students. The differences in the C3PDR model with the above-mentioned model or program are that the C3PDR model: 1) focuses on improving the creativity of junior high school students, 2) internalizes creative thinking techniques in student performance, so that the overall learning phase is characterized by the use of creative thinking techniques, 3) integrates knowledge creation with the creativity of science, 4) is designed for classroom learning.

The C3PDR teaching model was developed based on the scientific creativity theory of Hu & Adey (2002), the Scientific Creativity Structure Model (SCSM). SCSM is designed specifically for creativity in the field of science as a result of analyzing the meaning and creativity aspects found in the literature. Referring to SCSM, the creativity of science consists of 7 components, namely: component 1: fluency, flexibility and originality in using an object for unusual use, component 2: Degree of sensitivity to the problem of science, component 3: Ability to improve a technical product, component 4: scientific imagination, component 5: creative science problem solving ability, component 6: creative experimental ability, component 7: the ability to design creative science products. In addition, C3PDR teaching model supported learning theories and creativity theories are already established. Supportive learning theories are Piaget's cognitive theories, Bandura's social cognitive theories, Vygotsky's social constructivist theory and information-processing theory. The C3PDR developed teaching model consists of 6 phases, namely Creative exploration, Creative elaboration, Creative modeling, Practice scientific creativity, Discussion and Reflection.

C3PDR teaching model is needed as an alternative to support the spirit of UNESCO "Creativity is our hope" (Newton & Newton, 2014). The rapid development of technology, the increasing number of the world's population and the limitation of natural resources will cause economic problems. Intellectual products of creativity are seen as a source of wealth and a panacea to overcome the problem. Implementation of C3PDR teaching model is expected to answer the problems facing the world community.

Problem of Research

The problem of this research is: How is the feasibility of the C3PDR teaching model to improve student's scientific creativity of junior high school still low? The C3PDR teaching model is feasible if meets the criteria: valid, practical and effective. The C3PDR teaching model is valid if the mode of the content validity score and the validity of the content is at least included in the valid category, with the statistic percentage of agreement (R) greater than

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75%. Likewise, the learning materials are declared valid, if the mode of the validity score is at least included in the valid category, with the statistic percentage of agreement (R) greater than 75%. The teaching model is considered practical if the practicality score mode is at least included in the practical category, with the statistic percentage of agreement (R) greater than 75%. The C3PDR teaching model is effective if the n-gain value > .30, is in the moderate category and the probability value of paired t-tests (p) < .05 and at least 50% of students have an increased level of creativity from non-creative and less creative, rising to a level quite creative, creative and highly creative.

Research Focus

This research focuses on the analysis of the validity, practicality and effectiveness of the C3PDR teaching model to improve the creativity of science. The research questions are 1) whether the validity of the content and the validity of the constructs of the model are valid to enhance students' scientific creativity? 2) Whether the C3PDR model teaching materials are valid to support the implementation of C3PDR teaching model? 3) Whether the C3PDR teaching model is practically implemented in the classroom? 4) What is the improvement of students' scientific creativity after given C3PDR teaching model? 5) Whether the improvement of students' science creativity as a result of the C3PDR teaching model is significant? 6) what is the percentage of students, who experience an increase in creativity levels from non-creative and creative levels to creative, creative and highly creative levels.

Research Methodology

General Background

This development research was conducted in three stages: 1) preliminary research stage, 2) prototype preparation stage, and 3) assessment stage. In the preliminary research stage have conducted: a) needs analysis research of the importance of teaching models to improve the scientific creativity, b) theory and empirical studies as the basis of C3PDR mode, so that the draft hypothetical model is generated. At prototype preparation stage have been performed: a) generation of hypothetical model, b) validation of the hypothetical model qualitatively through focus group discussion (FGD) involvement of experts in science education, c) preparation and validation of teaching materials supporting the model carried out by experts in science education, d) limited trials and e) extensive trials. Trials were conducted at two junior high schools in East Kalimantan, Indonesia. A limited trial aims to analyze the implementation of the C3PDR teaching model through observation, while extensive trial aims to analyze the practicality and the effectiveness of C3PDR teaching model in improving students' scientific creativity. Limited and extensive trials were conducted in odd semester in academic year 2015/2016; i.e. in a class at a school with a total of 32 students and two classes with each class of 32 students, respectively.

Sample

The sample of the research on the limited trial is 32 students who are in Junior high school (SMP) 1 in Samarinda, Indonesia. While the sample in extensive trial is 64 students divided into two classes, each with the number of 32 students, which are in two different junior high schools, one class in SMP 1 and one other class in SMP 2 in Samarinda. The sample is determined using purposive sampling technique. Characteristic of the sample is that students have never received any training or creative thinking teaching, which is the main characteristic of the C3PDR model. The research was conducted on science subjects at motion topic and skeleton, joint and simple machine topic, in grade 8 in the odd semester of the 2015-2016 academic year.

Instrument and Procedures

Prior to application in the classroom, the C3PDR teaching model has been through a series of validation activities, through focus group discussions (FGD), expert judgment and limited trials. Expert judgment is using the model validation sheet instrument. The limited trial aims to find technical implementation issues that need to be done so that the C3PDR teaching model can be applied in accordance with the lesson plan. The limited trial data were obtained through observations made by the researcher himself and two teachers. The limited trial resulted in a number of recommendations that will be applied to the next trial, which is an extensive trial. The purpose of extensive trials is to test the practicality and effectiveness of the C3PDR model. Practical model data was obtained through classroom observation conducted by 2 teachers in each class, using observation sheet of C3PDR teaching model. The effectiveness of the model is tested using one group pre-test and post-test design.

Prior to the C3PDR teaching model, both classes were given a pre-test of scientific creativity, twice for two different topics, for the topic of motion and the topic of skeletons, joints and simple machines. The test instrument used is a scientific creativity test sheet that has been compiled based on the SCSM model, which consists of 7 components of science creativity and has been validated by science education experts. After the pre-test, both classes were given a C3PDR model by two teachers of science in their respective schools. During the lesson, teachers and students used teaching materials consisting of syllabus, lesson plans, student worksheets, student books and scientific creativity assessment sheet. All teaching materials have been validated by three experts, one is a professor in physics and two in the field of natural science education. Teaching practicability data were obtained through observations made by science teachers, using the observation sheet. Implementation of extensive trials was conducted for 7 weeks. Post-test of creativity of science is given to students after applied teaching with C3PDR model. Post-test is given twice for two different topics. The post-test is the same as the pre-test.

Data Analysis

There are three groups of data, namely model validity data, practical data, and model effectiveness data. Model validity data consist of content validity data, construct validity data, and data of teaching materials validity. Assessment options on all validation instruments, consist of 4 categories, that is not valid (score 1), less valid (score 2), valid (score 3) and very valid (score 4). The result of the validation assessment is recorded so that it is known to the expert score scoring mode, which is used to infer the validity of the content and the model construct and the validity of the teaching materials. The conclusion of this validity needs to be reinforced by the percentage of agreement between the statistical percentage of agreement (R), using the formula $R = [1 - \{(A - B) / (A + B)\}] \times 100\%$ (Borich, 1994). A is the highest score of all assessors and B is the lowest score of all assessors.

Assessment options on practical instruments consist of impractical (score 0), less practical (score 1), practical (score 3) and very practical (score 4). Practical assessment results are recorded so as to know the practitioner's (teachers') scoring mode used to deduce the practicality of the model. It is concluded that the practicality of the model needs to be reinforced by the percentage of agreement between practitioners' assessments, using the value of R.

Data of effectiveness is the form of creativity score of student, from the result of pre-test and post-test. Scientific creativity scores have no maximum value, so to determine the n-gain value, the data is converted first into the scale of 1 - 10 using the z distribution. The value of z is determined using the formula: z = [(student score - group average score) / standard deviation (SD)]. The mean score of the group and standard deviation was calculated by combining the pre-test and post-test scores. The n-gain values for each student were calculated using the formula, n-gain = (average post-test score - average pre-test score) / (maximum score - pre-test score) (Hake, 1999), the criteria are: n-gain > .70 high category, .30 < n-gain < .70 medium category and n-gain < .30 low category. The significance of scientific creativity enhancement was calculated using SPSS with probability $p < .05$. Determination of the increasing of scientific creativity level is done by converting the creativity data first into 5 scales. The criteria used are: score <1.375SD (not creative); 1.375SD ≤ score < - .275SD (less creative); - .275SD ≤ score < .825SD (creative enough); .825SD ≤ score <1.925SD (creative); 1.925SD ≤ score (very creative). The percentage of the number of students experiencing an increase in the level of scientific creativity from the level of non-creative and less creative to the level of creative, creative and highly creative is determined by adding the percentage of the number of students at those levels in the pre-test and post-test.

Result of Research

Assessment Results of Validity of C3PDR Teaching Model

The results of content validity are presented in Table 1. The scoring mode is in the very valid category. The statistical percentage of agreement between assessors is greater than 85%.

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Table 1. Assessment results of content validity.

Aspect of assessment	Assessment				Statistic percentage of agreement (R)
	Very valid	Valid	Less valid	Not valid	
C3PDR model development needs	9	3	0	0	93
State of the art of knowledge of model	1	2	0	0	86
Theory Support for the C3PDR Model	6	9	0	0	94
Planning and Implementing C3PDR	4	2	0	0	93
Learning Environment of the C3PDR	1	5	0	0	92
Use of Advanced Evaluation Techniques	4	2	0	0	86
Total	25	23	0	0	

The results of the construct validation assessment are presented in Table 2. The scoring mode is in the Valid category. The statistical percentage of agreement between assessors is over 85%.

Table 2. Assessment results of construct validity.

Aspect of assessment	Assessment				Statistic percentage of agreement (R)
	Very valid	Valid	Less valid	Not valid	
Overview of C3PDR	2	4	0	0	86
Theoretical and Empirical Support of the C3PDR Model	9	15	0	0	96
C3PDR Model Syntax	5	1	0	0	93
Phase 1: Creative exploration	2	7	0	0	90
Phase 2: Creative Elaboration	2	10	0	0	96
Phase 3: Creative Modeling	4	2	0	0	86
Phase 4: Practice Creativity Science	4	14	0	0	90
Phase 5: Discussion	4	2	0	0	93
Phase 6: Reflection	1	2	0	0	86
Social System	8	4	0	0	90
Principles of Reaction	5	4	0	0	86
Learning Environment and Classroom Management	2	4	0	0	92
Implementation of Evaluation	4	2	0	0	86
Total	52	71	0	0	

Assessment of the validity of teaching materials

The C3PDR teaching model is equipped with teaching materials consisting of lesson plans, student worksheets, student books and scientific creativity assessment sheets. Assessment results of three experts on the validity of teaching materials are presented in Table 3.

Table 3. Assessment result of teaching materials validity.

Teaching materials	Category	Statistic percentage of agreement (R)
Lesson plan	very valid	93
Student worksheet	very valid	98
Student book	very valid	89
Scientific creativity assessment sheets	very valid	95

Recommendations Based on the Result of Limited Trial

A limited trial resulted in five recommendations: 1) the ideal time required for each meeting was 3 x 40 minutes, 2) the experimental activities in the elaboration phase, carried out in two stages, interchangeably, 3) the number of students per group of 5, 4) Adjust the learning objectives according to the time allocated and 5) increase the time allocation for the elaboration phase and the practice scientific creativity phase.

Result of Practicality Assessment of C3PDR Teaching Model

Extensive trials produce practicality data and model effectiveness in enhancing students' scientific creativity. Practical data on the C3PDR teaching model in the 8E and 8K classes are presented in Table 4.

Table 4. Scoring mode of practicality assessment of the lesson plan implementation of C3PDR teaching model.

Activities	Score mode and Statistic percentage of agreement (R)						
	Lesson plan 1	Lesson plan 2	Lesson plan 3	Lesson plan 4	Lesson plan 5	Lesson plan 6	Lesson plan 7
Introduction	3 (97)	4 (97.3)	4 (94.7)	3 (97.1)	4 (97.3)	4 (94.7)	4 (94.7)
Main							
Phase 1: Creative Exploration	3 (100)	3 (91.4)	3 (96)	3 (97.6)	3 (100)	3 (100)	3 (92.3)
Phase 2: Creative Elaboration	3 (100)	3 (100)	3 (100)	3 (100)	3 (100)	3 (100)	3 (100)
Phase 3: Creative Modeling	3 (100)	3 (100)	3 (96)	3 (92.3)	3 (94.1)	3 (92.3)	3 (95.2)
Phase 4: Practice scientific creativity	3 (94.1)	3 (94.1)	3 (100)	3 (88.9)	3 (94.1)	3 (100)	3 (94.1)
Phase 5: Discussion	3 (94.1)	3 (94.1)	3 (94.1)	3 (100)	3 (94.1)	3 (94.1)	3 (94.1)
Phase 6: Reflection	3 (100)	3 (94.7)	3 (94.1)	3 (100)	3 (100)	3 (94.1)	3 (94.1)
Closing	4 (88.9)	3 (88.9)	3 (100)	3 (88.9)	3 (88.9)	3 (88.9)	3 (88.9)
Mode	3	3	3	3	3	3	3
Description	Practical	Practical	Practical	Practical	Practical	Practical	Practical

Based on Table 4, the implementation of lesson plan 1, 2, 3, 4, 5, 6 and 7 are in the Practical category. The statistical percentage of agreement between observers is greater than 85%, which means that teaching steps can be easily done, using a synchronized learning resource, and in accordance with defined learning objectives.

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Results of the Effectiveness Assessment of the C3PDR Teaching Model

The effectiveness data of the C3PDR teaching model for the 8E grade are presented in Table 5 which shows a large increase in the scientific creativity of for each component, which is indicated by the n-gain value, and the probability p, which is caused by the application of the C3PDR teaching model. Based on Table 5, there are four n-gain values less than .30 and they are in the Low category and there are nine n-gain values of more than or equal to .30. They are in the Medium category. There is one component on the skeleton, joints and simple machines topic whose n-gain values can't be determined due to technical reasons. All probability values $p < .05$ showed a significant increase in science creativity at a = 5%.

Table 5. Average score of each component of scientific creativity in 8E grade.

Scientific Creativity	Average score on motion topic		*n-gain*	Average score on skeleton, joint and simple machine topic		n-gain
	Pre-test	*Post-test*		Pre-test	Post-test	
Component 1	.19	2.77	.30	.00	3.32	.64
Component 2	2.37	10.69	.26	2.33	7.62	.21
Component 3	5.13	11.34	.24	1.52	8.92	.39
Component 4	1.00	7.16	.31	5.00	10.62	.32
Component 5	.00	1.70	.23	-	-	-
Component 6	9.69	31.28	.33	5.6	18.26	.32
Component 7	1.87	9.45	.35	1.32	7.08	.32

Table 6 presents the average conversion scores of pre-test and post-test science creativity for motion material and simple frame and machine materials and n-gain values for the entire component. The increase of students' scientific creativity, as a whole after C3PDR teaching model applied, can be seen from the n-gain value by comparing the pre-test and post-test scores. The n-gain for motion topic is .43 and for skeleton, joint and simple machine topic n-gain is equal to .42. This n-gain value is in the Medium category.

The p-value of t-paired test results on motion topic and skeleton, joints and simple machine is less than .05, respectively, which means there is a significant difference between the mean scores of scientific creativity before the C3PDR teaching model is applied, compared to the mean score scientific creativity after being applied. The average score of scientific creativity after the C3PDR teaching model applied was higher than the average score of scientific creativity before it applied.

Table 6. Conversion of the average score and n-gain of scientific creativity in 8E grade.

Component	Motion topic		Skeleton, joints and simple machine topic	
	Pre-test	Post-test	Pre-test	Post-test
The highest score	50	100	60	100
The lowest value	30	30	30	40
Average	38.70	64.10	37.60	62.80
n-gain	.43		.42	
Probability	$p < .05$		$p < .05$	

The increased level of student' scientific creativity of 8E grade, presented in Figure 1 for the motion topic and Figure 2 for skeleton, joints and simple machine topic.

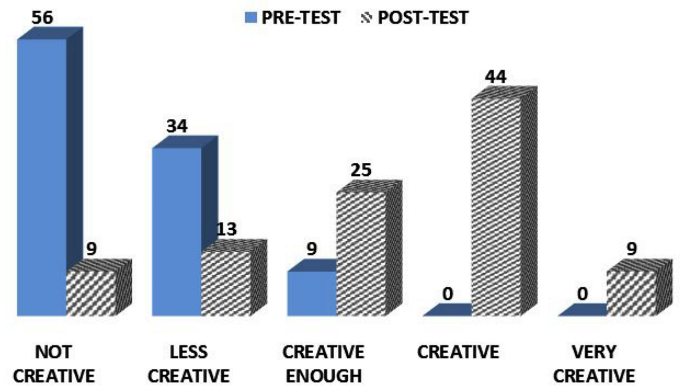

Figure 1: Percentage of students at each level, before and after the C3PDR teaching model applied to motion topic in 8E grade.

Figure 1 shows the tendency of increasing the level of students' scientific creativity on motion topic, from non-creative and less creative level to a higher level; creative enough, creative and highly creative. There were 69% of students that had an increased level of creativity. Pre-test shows that only 9% of students are being at level, enough creative, creative and very creative. After post-test, 79% of students are at that level. The same trend also occurs in the skeleton, joints and simple machine topic shown in Figure 2. There were 62% of students that had an increased level of creativity. Initially, only 8% of students are being at level, enough creative, creative and very creative, increased to 70% of students at that level after the C3PDR teaching model applied.

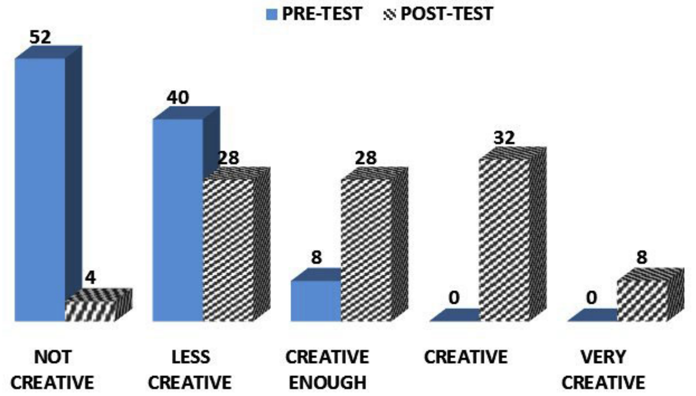

Figure 2: Percentage of students at each level, before and after the C3PDR teaching model applied to skeleton, joints and simple machine topic in 8E grade.

The effectiveness data of C3PDR teaching model in 8K grade is presented in Table 7. Based on Table 7, there are two n-gain values less than .30, which are in the low category and there are twelve n-gain values of more than or equal to .30 in Medium category. All values of p< .05 indicate a significant increase in scientific creativity.

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Table 7. Average score of each component of scientific creativity in 8K grade.

Scientific Creativity	Average score on motion topic		*n-gain*	Average score on skeleton, joint and simple machine topic		n-gain
	Pre-test	*Post-test*		Pre-test	Post-test	
Component 1	.15	7.81	.36	1.33	6.12	.25
Component 2	1.50	7.17	.30	3.00	12.09	.34
Component 3	1.58	7.83	.34	2.00	3.13	.35
Component 4	.00	2.61	.31	5.48	12.91	.36
Component 5	.56	1.80	.43	.33	.96	.14
Component 6	17.62	29.58	.31	5.04	21.26	.35
Component 7	1.96	9.81	.40	1.30	4.56	.33

Table 8 presents the conversion of the average pre-test and post-test scores of scientific creativity for motion topic and skeleton, joints and simple machine topic, for all components and n-gain. The improvement of students' scientific creativity after C3PDR teaching applied can be seen from the normal gain value by comparing the pre-test and post-test scores. The normal gain for motion topic is .42 and for skeleton, joint and simple machine topic, the normal gain is .41. This normal gain value is in the moderate category.

The result of paired t test on motion material and frame material, simple joint and plane, p value < .05, which means there is a difference between the average score of creativity of science before the teaching model applied to the average score of creativity of science after the model is applied. The average score of scientific creativity of after the C3PDR teaching model is applied, higher than the science creativity score before the model applied.

Table 8. Conversion of the average score and n-gain of scientific creativity in 8K grade.

Component	Motion topic		Skeleton, joints and simple machine topic	
	Pre-test	Post-test	Pre-test	Post-test
The highest score	50	100	70	90
The lowest value	20	40	20	40
Average	36.50	62.30	37.10	62.90
n-Gain	.42		.41	
Probability	$p < .05$		$p < .05$	

The increase of the scientific creativity level of the 8K grade students, for the motion topic is presented in Fig. 3 and for the skeleton, joints and simple machine topic shown in Figure 4.

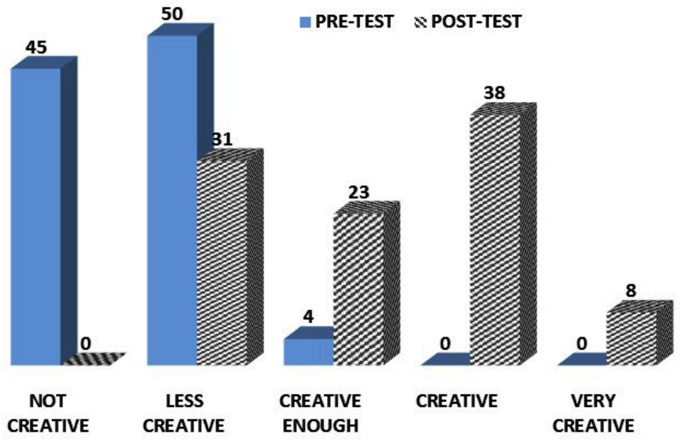

Figure 3: **Percentage of students at each level, before and after the C3PDR teaching model applied to motion topic in 8K grade.**

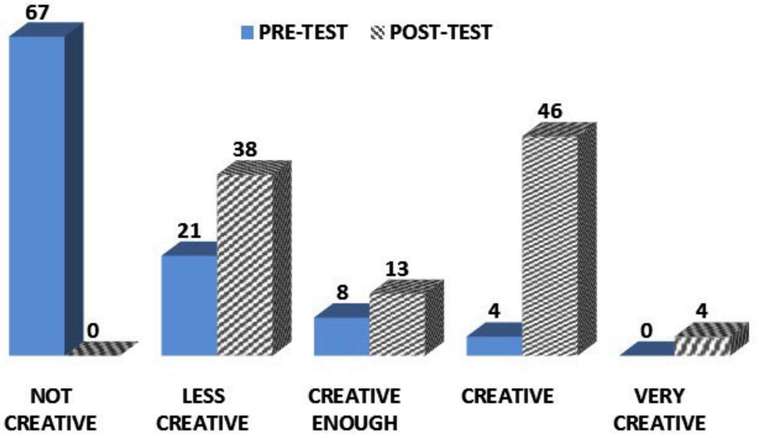

Figure 4: **Percentage of students at each level, before and after the C3PDR teaching model applied to skeleton, joints and simple machine topic in 8K grade.**

Figure 3 shows the tendency of increasing the level of students' scientific creativity on motion topic, from non-creative and less creative level to a higher level; creative enough, creative and very creative. There were 65% of students that had an increased level of creativity. Pre-test shows that only 4% students are being at level, enough creative, creative and very creative. After post-test, 69% of students are at that level. The same trend also occurs in the skeleton, joints and simple machine topic shown in Figure 2. There were 51% of students that had an increased level of creativity. Initially, only 12% of students are being at level, enough creative, creative and very creative, increased to 63% of students at that level after the C3PDR teaching model applied.

Discussion

The content validity of the C3PDR teaching model is in the very valid category as shown in Table 1. This is because this is supported by: 1) the latest research trends, 2) cutting edge knowledge, 3) meeting the competency-oriented curriculum of the 21st century, 4) using international standardized assessment techniques. It is the latest research trends, namely creativity that is an important capital for someone to succeed in the life of the present and future. The C3PDR model meets the needs of the 21st century competency framework, one of which is creativity

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(Partnership for 21th century learning). Specifically, in Indonesia the C3PDR teaching model is able to meet the needs of the 2013 Curriculum, the most important goals of which is to form creative Indonesian children ("Regulation of the Minister of Education and Culture of the Republic of Indonesia," 2013)

The C3PDR teaching model is designed based on the state of the art of knowledge and empirical support from the latest research results as presented in Table 1. The C3PDR teaching model is designed using the theoretical basis of educational psychology figures listed in the books International standard. The C3PDR teaching model is supported by established learning theories such as cognitive theory of learning, social cognitive theory, social constructivist theory, Vygotsky theory and meta-cognition. In addition, it is also supported by the theory of creativity, namely componential theory and cognitive theory for creativity. Empirical support for the development of creativity of science and the way of assessment is often found in recent international journals. The updated C3PDR teaching model is supported also by its ability to meet the demands of 21st century competence, namely the mastery of science and scientific creativity. The C3PDR teaching model environment is also structured on an established theoretical basis and the latest empirical foundation. Other updates of the C3PDR teaching model can be seen from the way in which the assessment refers to the reference of international standards in the field of scientific creativity. Assessment of the scientific creativity refers to SCSM model of Hu &Adey (2002) with seven components of scientific creativity as its indicators.

The construct validity of the C3PDR model is in the valid category as presented in Table 3. Learning theories and empirical data used in the C3PDR model are logically used to enhance students' science creativity. The C3PDR model is designed logically and can also be seen from the syntax of the model, social system, reaction principle, learning environment and classroom management and its assessment. The logic of the model is first seen from the logical sequence of phases and the inter-phase linkages in the C3PDR model syntax. The mode in this component is in the valid category. The sequence of phases of the C3PDR model begins the phase of creative exploration, which identifies various issues related to the topic, both concepts, terms, theories and so on. In the creative exploration phase, students reveal the questions they want to know, followed by further investigation, questions that will be explored further by either extracting information from various sources and extracting information through experiments in the science process skills, which will be experienced in the creative elaboration phase.

The learning outcomes of the creative elaboration phase will be used in developing the scientific creativity. According Amabile (2012), mastery of field is one important element in the creativity. Another important element in the creativity of science is the creative thinking skill. Therefore, before the practical scientific creativity phase, students need to be shown how creative thinking works through creative modeling. In order to awaken the students what they have done and what they already understand, a reflection phase is needed with the use of meta-cognition theory.

Social system scores acquire a mode that is in the Very valid category. This assessment is very reasonable, because in the C3PDR teaching model, as stated in the C3PDR teaching model book, there is a clear relationship between teachers and students, the role of teachers as facilitators and as mentors and can be realized in each phase.

The reaction principle obtains a mode that is in the Very valid category. How teachers react to student responses is clearly stated in the C3PDR teaching model book. The principle pattern of such reactions can be realized according to the C3PDR model syntax.

The learning environment and classroom management obtains a mode that is in the Very valid category. The learning environment listed in the C3PDR teaching model book, supports the achievement of scientific creativity. The learning environment is designed in such a way that it meets the principles; 1) respect all ideas and views and conduct activities that do not need to be assessed. 2) support students' autonomy that is, teachers give students choices and accommodate inputs; 3) support the occurrence of brainstorming and collaboration; 4) teachers should imitate students' enthusiasm and assess creative work and design classroom activities so students are given value for their creative thinking 5) give enough time during creative activity. In addition, implementation of the evaluation obtained a mode that is in the category of Very valid, which indicates that the evaluation is used in accordance with the purpose of the model.

The C3PDR teaching model can be implemented according to the scenario by accommodating recommendations from the results of a limited trial. The addition of time is necessary in the elaboration phase and the practice scientific creativity phase, because in the elaboration phase students construct knowledge and use it in the phase of practice scientific creativity. A total of 5 students per group is needed because it is more effective at brainstorming using creative thinking techniques to accomplish creativity tasks on student worksheets.

The practicality of implementing the C3PDR teaching model listed in the lesson plan is in the Practical category as shown in Table 4. Each phase of the C3PDR teaching model can be implemented according to the written scenario, for each 3 x 40 minutes' meeting. The practicality of this C3PDR model implementation is not separated from the accompanying teaching materials such as lesson plans, student worksheets, student books and scientific creativity assessment sheets, which have been validated and included in the Very valid category as presented in Table 3.

The C3PDR teaching model proved to be effective in enhancing the students' scientific creativity, which is shown by the n-gain and probability values (p), both for each component and for the overall component. n-gain for all components in two classes and two topics ranged in the range of .40 in the medium category and the probability value $p < .05$, as shown in Table 6 and Table 8. n-gain for each component of creativity tends to be greater than .30 in the moderate category, unless there are five n-gain values in the low category of the overall n-gain values in Table 5 and Table 7. However, the overall probability (p) value is less than .05, which indicates that the C3PDR teaching model is proven significantly, able to improve students' scientific creativity. Effectiveness is also strengthened by the increase in the number of students who are at the level of creative enough, creative and very creative by 50% after applied C3PDR teaching model.

The increase of students' scientific creativity by intervention of C3PDR teaching model, consists of three components, namely: 1) domain-relevant skills, 2) creativity-relevant processes, i.e. cognitive and personality processes that support the process of thinking on new ideas and 3) task motivation, especially intrinsic motivation in completing tasks caused by interest, joy and personal challenges and 4) meta-cognition.

In this C3PDR model, the focus of model intervention is on the mastery of knowledge and creative thinking skills while other factors, namely the personality processes that support thinking to new ideas, intrinsic and environmental motivations have not been given specific intervention. Model interventions on mastery of knowledge and creative thinking skills have been able to increase students' scientific creativity.

The increase of scientific creativity due to C3PDR model interventions on the acquisition of relevant knowledge in accordance with previous research results, conducted by Zhang & Gheibi (2015) and Poon, Au, Tong & Lau (2014), Fotis (2010), Nami, Marsooli & Ashouri (2014) and Huang, Peng, Chen, Tseng & Hsu, (2017). Zhang & Gheibi (2015) shows the interaction of knowledge, intrinsic motivation and sense of security in teamwork will produce maximum creativity. Poon, Au, Tong & Lau (2014), points out that knowledge and confidence boost students' creativity. Fotis research shows that there is a strong relationship between creativity to divergent thinking ability, caused by the existence of knowledge factor. Nami, Marsooli & Ashouri (2014) finds a significant relationship between academic achievement and creativity. Other supporting results are conducted by Sendurur, Ersoy & Cetin (2016), which show that science creativity scores will improve if students are close to or familiar with the topic of scientific creativity tests provided.

Mastery of knowledge in the C3PDR model is enhanced in phase 2, i.e. creative elaboration. Elaboration will improve student learning outcomes (Akyol, Sungur, Tekkaya, 2010). In this phase the students construct their knowledge, deepen their mastery through various activities, such as reading, doing tasks on the student worksheet, doing experiments or discussing collaboratively with their group mates. Collaborative learning was chosen because it proved able to improve student creativity (Maria, Dimitris, Garifallos, Athanasios & Roumeliotis, 2015); (Cocu, Pecheanu & Susnea, 2015); (Laisema & Wannapiroon, 2014); (Bettonia, Bernharda & Bittela, 2015). Through collaborative learning, students work together, are in the same position, mutually teach and complement each other.

Creative thinking is one of the characteristics of the C3PDR teaching model. Almost all phases are colored by the use of creative thinking techniques. The use of creative thinking techniques proved to increase the creativity of students' science Cheng (2001), Hu, Wu, Jia, Yi, Duan, Meyer & Kaufman (2013); Al-Khatib (2012); Park (2011). In Phase 1, Creative Exploration, synectic techniques are used to train students' divergent thinking skills, which is one of the characteristics of creative people. Synectics technique is supported by research results from Aiamnya & Haghanib (2012) and Tajari &Tajari (2010). In phase 1 there is also organizing topics using lotus blossom technique, which is a medium to write down the results of the synectics thinking technique. Organizing the topic will improve student learning outcomes (Akyol, Sungur, Tekkaya, 2010).

In phase 3, Creative modeling, teachers serve as models to model how to use creative thinking techniques, which will be used in the next phase. Several studies have shown that modeling supports increased creativity, among them are Shalley & Perry-Smith (2002), Yia, Plucker & Guo (2015) and Show (2017). The use of creative thinking techniques, there is in the student book, to complement this model, so that when the teacher demonstrates its use, students have early knowledge. This is important given that the modeling can be successful according to its purpose. Modeling will work if there is attention from students, there is a process of imitating and there is

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a process of further practice. When the teacher exemplifies creative thinking techniques, students observe and imitate what teachers do.

The process of further practice is done by students in Phase 4, Practice Scientific Creativity. Based on the tasks on the worksheet, practice further using creative thinking techniques, namely ask questions, problem reversal, attribute listings, brainstorming, lotus blossom and synectic. The use of creative thinking techniques is adapted to the components of the scientific creativity to be trained. An example for science imagination component, the technique used is problem reversal supported by brainstorming. Create scientific questions component, using ask question techniques that are assisted with synectics thinking techniques, lotus blossom and brainstorming. Brainstorming techniques are always used in conjunction with other techniques, because the C3PDR teaching model prioritizes collaborative work.

Phase 5, Discussion and Phase 6, Reflection gives students the opportunity to assess their work, what they have done, what they already know and what they do not know. Both phases are the application of meta-cognition theory. Several studies have shown that meta-cognition plays a role in enhancing creativity, among them are Hao, Ku, Liu, Hu, Bodner, Grabner & Fink (2016), Kaufman, Beghetto & Watson (2015) and Akyol, Sungur, Tekkaya (2010).

Creativity is highly determined by motivation. The scientific creativity is highly dependent on motivation, especially intrinsic motivation. Therefore, the overall classroom environment, aimed at improving students' intrinsic motivation. Several studies that show the influence of motivation on creativity are by Liu, Jiang, Shalley, Keem & Zhou (2016), Blaskovaa (2014), Ghasemi, Rastegar, Jahromi & Marvdashti (2011), Penga, Cherng, Chenc & Linc (2013). The learning atmosphere that is addressed in the C3PDR model includes giving sufficient time to complete the tasks in the student worksheet, giving more autonomy to the students especially in giving answers, so the students dare to write down their own answers, postpone judgments, and appreciate all opinions.

Based on the above discussion it is very logical if the C3PDR teaching model able to improve the student scientific creativity. The development research that produced this C3PDR model reinforces the results of research that mastery of knowledge, creative thinking, collaboration, modeling, meta-cognition and motivation support the creativity. Further research needs to be done to perfect the C3PDR teaching model. Further research in question is to conduct a series of advanced trials involving more classes until the C3PDR model is ready for widespread use.

Conclusion

Based on data and discussion, it indicates that: 1) the C3PDR teaching model proves to be valid, practical and effective. The validity of the content and the validity of the constructs are in the Very valid category, indicated by validity score mode in very valid category with R > 85%. The validity of the learning materials is in the Very valid category, indicated by the validity score mode in very valid category with R > 85%. 2) The practicality of the model including the practical category, indicated by the mode of practicality score in the Valid category with the value R> 85%. 3) The C3PDR model proved to be significantly effective in improving students' scientific creativity with n-gain = .42, and $p < .05$, being in the moderate category and at least 50% of students experiencing improve in creativity levels from the non-creative and less creative levels to the level Creative enough, creative and very creative. It can be concluded that the C3PDR teaching model, feasible to be used to improve the scientific creativity of junior high school students.

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