JOURNAL OF BALTIC SCIENCE EDUCATION

ISSN 1648-3898 /Print/
ISSN 2538-7138 /Online/

EFFECTIVENESS OF CREATIVE RESPONSIBILITY BASED TEACHING (CRBT) MODEL ON BASIC PHYSICS LEARNING TO INCREASE STUDENT'S SCIENTIFIC CREATIVITY AND RESPONSIBILITY

Suyidno,
Mohamad Nur,
Leny Yuanita,
Binar Kurnia Prahani,
Budi Jatmiko

Abstract. *The Creative Responsibility Based Teaching (CRBT) model is an innovative physics-teaching model designed to enhance students' scientific creativity and responsibility. Therefore, this research aims to analyze the effectiveness of CRBT model to improve scientific creativity and first year students' responsibility on Basic Physics learning in academic year 2016/2017. This research used one group pre-test and post-test design on 144 students divided into 4 groups at University of Lambung Mangkurat, South Kalimantan (Indonesia). The data collection methods were conducted by using: scientific creativity tests emphasized on unusual uses indicator, problem finding, product improvement, creatively science problem solving, creatively experiment designing, and creatively product design; questionnaire of responsibility emphasized on: participatory indicator, respecting others, cooperation, leadership, and delivering opinion; and interviews. The data analysis technique was done by using paired t-test / Wilcoxon test, n-gain, and ANOVA / Kruskal-Wallis test. The results showed that there was a significant increase in students' scientific creativity and responsibility at α = 5%, with n-gain average of moderate category, and both were not different (consistent) for all four groups. Thus, the CRBT model is effective for enhancing students' scientific creativity and responsibility.*
Keywords: *creative responsibility based teaching, physics learning, responsibility attitude, scientific creativity, first year students.*

Suyidno
Lambung Mangkurat University, Indonesia
Mohamad Nur, Leny Yuanita, Binar Kurnia Prahani, Budi Jatmiko
State University of Surabaya, Indonesia

Introduction

Indonesia has abundant natural resources (SDA) and human resources (HR) of 240 million people, these things are believed to be the main supporting element for this nation to be great in the future (Rohkman, Syaifudin, & Yuliati, 2013). At this point, physics education has an important contribution in preparing creative and responsible human resources as a nation change agent. The Republic of Indonesia government's policy through the Permenristekdikti No. 44 on the National Standards of Higher Education; it states that the achievement of graduate's competence is preferred through a learning process that develops scientific creativity and responsibility in searching and finding science (Minister of Research, Technology and Higher Education, 2015). Similarly, Jatmiko, Widodo, Martini, Budiyanto, Wicaksono, & Pandiangan (2016) have shown that decision-based learning and problem solving can improve the learning achievement of the 6th level INQF Indicators. Students should be prepared as a part of modern society that would later require scientific creativity to solve life problems (OECD, 2014), adapt to new demands flexibly (Greiff et al., 2014), and technological innovation (ADB, 2014). Students also need responsibility for improving learning quality (Saliceti, 2015, Zakar & Baykara, 2014) and directing their creative products for mutual benefit (Velev, 2004; Ozdemir & Dikici, 2017; Sternberg, 2009).

Scientific creativity includes learning and innovation skills, as well as responsibility as part of life skills and careers in the 21st century (Blascova, 2014). Students are mandated to be equipped with 21st century skills to facilitate their success in their future jobs and careers (Sitti, Sooperak, & Sompong, 2013; Blascova, 2014). Based on the explanation above, development of scientific creativity and responsibility is believed to be a key factor in the rise of powerful countries.

But the reality shows the opposite situation, the results of literature studies and preliminary research indicate that students' scientific creativity and responsibility are still low and difficult to be improved by lecturers because they are still considered theoretical and abstract (Bakir & Oztekin, 2014; Kadayifci, 2017; Kang, Park, & Hong, 2015; Susantini, Isnawati, & Lisdiana, 2016; Susantini, Lisdiana, Isnawati, Al Haq, & Trimulyono, 2017; Suseno, 2010; Suyidno, Nur, Yuanita, Sunarti, & Prahani, 2016). Scientific creativity has in common with common creativity in divergent thinking, but rather emphasizes science experiments, finds science problems and solves creative problems of science, and creative science activities (Siew, Chong, & Chin, 2014; Raj & Saxena, 2016). Factors that allegedly affect the low scientific creativity is the process of physics learning in Indonesia that is generally separated from the practical subjects, physics learning tends to be emphasized on the mastery of physics concepts and solving physics problem mathematically. Uncreative students tend to be more confident in other people's ideas, not their own creative ideas (Rietzschel, Bernard, & Wolfgang, 2010). All this time, lecturers feel difficult to help students understand the physics concepts that are considered abstract, so the development of scientific creativity tends to be ignored (Suyidno & Nur, 2015). This is reinforced by the results of Suseno's (2010) survey that students in Java and Sumatra Indonesia generally find difficult to understand abstract physical materials, let alone developing scientific creativity in problem solving. In addition, the roles of student responsibilities in Basic Physics learning are also not as expected. The fact also shows that responsibility learning has not been integrated in the process of physics learning in the classroom (In & Thongperm, 2014). As a result, all this time students understand responsibility only as knowledge and not yet accustomed to apply it in their own learning process (Suyidno, Nur, Yuanita, Sunarti, & Prahani, 2016).

One of the alternative solutions that are believed can improve scientific creativity and responsibility of students in Basic Physics learning is by using CRBT model. This CRBT model is an innovation of Problem Based Learning (PBL), Learn to Think (LTT), and Science Creative Learning (SCL)-based projects that have enhanced students' scientific creativity and responsibility (Minister of Research, Technology and Higher Education, 2015), but still has some disadvantages as follows. Some weaknesses of PBL model application in physics learning are: (1) lack of feedback so it is also less involving the role of student responsibility in controlling the learning process itself (Gorghiu, Draghicescu, Cristea, Patrescu, & Gorghiu, 2015); (2) scientific creativity and imagination are emphasized in the construction of scientific knowledge, but less related to the nature of contemporary science and its application (Moutinho, Torres, Joana, Fernandez, & Vasconcelos, 2015); (3) the instruction in exploring is less profound, thus it less training the unusual uses, writing down student's own research questions and seeking answers to those questions (Nariman & Chrispeels, 2015); and (4) less involving the students' responsibility for being successful in their own learning process (English & Kitsantas, 2013). The weaknesses of applying LTT model to improve scientific creativity (Hu, Wu, Jia, Yi, Duan, & Meyer, 2013) are: (1) less training unusual uses and creatively experiment designing; and (2) developed for secondary schools so it needs to be reviewed if applied to higher education. The weaknesses of the project-based SCL model as an innovation from PBL to enhance scientific creativity are: (1) there is no continuous training to help students mastering creative thinking activities, (2) no further monitoring of creative thinking activities. Students are considered to master the creative thinking activity after completing the project tasks; (3) the instruction in exploration is still less profound as is the PBL; and (4) experimental activities are in accordance with the procedures in the LKS, so that students are less training the unusual uses, problem finding, and creatively experiment designing. CRBT model is expected to be applied for students in Department of Mathematics and Natural Sciences, Faculty of Teacher Training and Education, University of Lambung Mangkurat (ULM) in South Kalimantan Province - Indonesia, covering Study Program: Physics, Science, Chemistry, and Biology; which have a wide range of scientific knowledge, educational level, culture, and age. In line with Blascova's (2014) recommendation, the CRBT model maximizes the role of student responsibility in succeeding their scientific investigation and scientific creativity tasks. The development of comprehensive scientific creativity and responsibility in the classroom makes learning more effective (Zaripova & Kalatskaya, 2016). Students are familiarized in situations and conditions in which they are able to internalize scientific creativity and responsibility in physics learning activities. This is done because the development of scientific creativity is thought to produce new technological products that bring the benefit or destruction of mankind, so it takes the responsibility to bring the products of creativity in a positive direction in the various fields of information, communication and technology application (Ozdemir & Dikici, 2017; Sternberg, 2009; Velev, 2004). Therefore, the CRBT model is designed specifically to enhance students' scientific creativity and responsibility in Basic Physics , which is in line with the demands of 21st century curriculum and skills that refers to the John Dewey flow of problem solving and the scientific creativity hypothesis (Hu & Adey, 2010), and which is supported by cutting-edge learning theories (e.g. metacognitive skills, reciprocal causation models, constructivism, advanced organizers, scaffolding, and complex cognitive processes).

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

In line with the role of PBL (Arends, 2012), the role of the CRBT model is presenting the ill-defined problem, facilitating responsibility through scientific investigation and scientific creativity tasks, as well as student-centered learning. Therefore: a) developed CRBT model syntax including: (1) generating creative responsibility, (2) organizing creative learning needs, (3) guiding group investigations, (4) establishing responsibility for demonstrating scientific creativity, and (5) evaluation and reflection (Suyidno, Dewantara, Nur, & Yuanita, 2017; Suyidno, Nur, Yuanita, & Prahani, 2017). b) CRBT model characteristics including: (1) the existence of ill-defined problem, presented in the form of open questions. Students are encouraged to propose as many problems as possible to be investigated, (2) creative responsibility, each student has a responsibility to be creative and produce creative products for the common good, (3) creative learning needs, the availability of laboratory equipment, ICT media, various reference sources, and professionalism of lecturers in teaching, (4) group investigation, beginning with problem finding, selecting problem formulation, creatively experiment designing, and creatively science problem solving, (5) tasks of scientific creativity, extending the reach of students' creativity and responsibility in exploring the various impacts of science and technology development along with alternative solutions, and (6) producing creative products and presenting them, the results of the creativity are not in a form of physical object, but in the form of new ideas, the incorporation of ideas in a new way, unique problem solving. Creative products are poured in the form of test items of scientific creativity along with alternative solutions, then the results are communicated scientifically. The indicators of scientific creativity (Hu & Adey, 2010) and responsibility (Escarti, Wright, Pascual, & Gutierrez, 2015; Rolina, 2014).

Problem of Research

The effectiveness of the CRBT model is measured through: (1) the increase in students' scientific creativity and responsibility significantly at the level of significance, $\alpha = 5\%$; (2) the average level of students' scientific creativity improvement and responsibility determined by the normalized gain value (average n-gain) at least in moderate category; and (3) the average level of students' scientific creativity improvement and responsibility in the four groups that are not significantly different. The value of n-gain on students' scientific creativity and responsibility is determined by the equation: n-gain = (score post-test - score pre-test) / (maximum score - pre-test score) (Hake, 1998). According to the following criteria: (1) if n-gain $\geq .7$ (high), (2) if $.3 <$ n-gain $< .7$ (moderate), and (3) if n-gain $\leq .3$ (low). Therefore, the main problem of this research is to analyze the effectiveness of the CRBT model on improving students' scientific creativity and responsibility on Basic Physics learning. The aim of this research is to analyze the effectiveness of CRBT model on improving students' scientific creativity and responsibility of study program: physics, science, chemistry, and biology in Basic Physics teaching.

Research Focus

The focus problem in this research includes: (1) whether there is a significant (statistically) increase and responsibility before and after the CRBT model is applied; (2) how much is the level of students' scientific creativity enhancement and students' responsibility before and after the applied model CRBT, (3) whether there is an average difference in level of scientific creativity improvement and responsibility after learning with CRBT model in all four groups.

Research Methodology

General Background

This research was conducted at Lambung Mangkurat University in March 2016 - January 2017. The scope of this research is the first-year students who took Basic Physics course in academic year 2016/2017. This research is emphasized on the analysis of the CRBT model effectiveness by analyzing the increase of scientific creativity and the responsibility of the students before and after following the process of physics teaching with CRBT model. The effectiveness of the CRBT model was determined based on a statistically significant increase in pre-test and post-test of scholarly creativity and student responsibility, as well as the mean n-gain determined by criteria: low, medium, and high.

Sample

The selection of samples is based on the Slovin formula, i.e. Sample = [population / (1 + e^2 x population)] with error tolerance e = 5% (Sevilla, Ochave, Punsalam, Regala, Uriarte, 1984). In this research populations were taken from 223 students at Lambung Mangkurat University, South Kalimantan, Indonesia. The sample in this research were 144 students at Lambung Mangkurat University, South Kalimantan, Indonesia; which are arranged in the four groups: group-1 (students of Physics Study Program), group-2 (students of Science Study Program), group-3 (students of Chemistry Study Program), and group-4 (students of Biology Studies Program). Each group consisted of 36 students who took Basic Physics course in academic year 2016/2017.

Instrument and Procedures

This research used one group pretest-posttest design, i.e. O1 X O2 (Fraenkel, Wallen, & Hyun, 2012). The learning process begins by giving pre-test (O1). Each student is asked to work on a pre-test of scientific creativity, then after that, the student is asked to fill out a questionnaire of student responsibility. The scientific creativity test consists of 7 items referring to the scientific creativity indicator adapted from Hu & Adey (2010), including: unusual uses, problem finding, product improvement, creatively science problem solving, creatively experiment designing, and creatively product design. The Basic Physical Materials used in scientific creativity tests include electric current and resistance, direct current electricity, magnetism, faraday law, alternating current circuits, and power on ac circuits. Student responsibility tests (responsibility assessment sheet and questionnaire responsibility) adapted from Escarti, Wright, Pascual, & Gutierrez (2015) are emphasized on participation, respect for others, cooperation, leadership, and opinion. After the pre-test, the lecturers provide science skill training as the initial provision for the students before following the physics learning process. This training uses students' science activity (LKM) skills in the process of science, including: formulating problems, formulating hypotheses, identifying variables, making operational definitions of variables, designing data tables, designing experimental procedures, analyzing data, and drawing conclusions. Lecturers apply CRBT model and SAP in each group (X). Trap unit of lectures are specifically designed to be integrated with science process skill indicators, including: formulating problems, formulating hypotheses, identifying variables, making operational definitions of variables, designing data tables, designing experimental procedures, conducting experiments, analyzing data, and drawing conclusions; indicators of scientific creativity consist of: unusual uses, problem finding, product improvement, creatively science problem solving, creatively experiment designing, and creatively product design; and indicators of responsibility consist of: participation, respect for others, cooperation, leadership, and convey opinions at each phase of learning. The learning process ends with a post-test (O2). Each student is asked to do post-test of scientific creativity, then after that, the student is asked to fill out the questionnaire of student responsibility. In addition, an in-depth interview was conducted for several students to clarify the problems found during the basic physics learning. The interview procedure includes the following: 1) Selecting students who have n-gain of scientific creativity and responsibility in low criteria (5 students), moderate (5 students), and high (5 students); 2) Conducting in-depth interviews on all selected students; 3) Doing Focus Group Discussion to verify interview results; 4) Summarize the results of the interview as in Table 8.

The results of previous research by Suyidno, Nur, Yuanita, & Prahani (2017) on the validation of CRBT and trap unit of lecture models by three physics teaching experts, showed that from the score range between 0 to 4 it was obtained the average score for content validity: 3.41 (very valid) ; construct validity: 3.42 (very valid); syllabus: 3.95 (very valid); lesson plan: 3.95 (very valid); textbook: 3.80 (very valid); MFI-Skills Process of Science: 3.73 (very valid); MFI-Scientific Creativity: 3.86; Scientific Creativity test: 3.81 (very valid); sheet of LP Responsibilities: 3.89 (very valid); and responsibilities questionnaire: 3.83 (very valid). The results of this research indicate that the developed CRBT model meets the criteria of content validity (needs and updates), construct validity (consistency between model components), and has support systems (Syllabus, Lesson Plan, Textbook, MFI and LP) in very valid category. The reliability of the scientific creativity assessment sheets and responsibilities were calculated using Cronbach's alpha, which shows the following results: a) Reliability of scientific creativity assessment sheet: .93 (high reliability); b) Reliability of responsibility assessment sheet: .63 (moderate reliability); and c) Reliability of Questionnaire responsibility: .63 (moderate reliability).

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Data Analysis

The data analysis is done as follows. Indicators of scientific creativity consist of: unusual uses, problem finding, product improvement, creatively science problem solving, creatively experiment designing, and creatively product design are number of fluency, flexibility, and originality points (Hu & Adey, 2010). In this research there are 7 indicators of scientific creativity in basic physics courses including: (1) Unusual Uses (UU), determining the usefulness of an object creatively for scientific purposes on basic physical materials; (2) Problem Finding (PF), level of sensitivity to science problems. Students are encouraged to make as many problem formulations as possible for investigation; (3) Product Improvement (PI), improving the usefulness of a product technically; (4) Scientific Imagination (SI), scientifically imaginable. Students can provide imaginative answers that may become a reality in the future; (5) Creatively Science Problem Solving (CSPS), students are given contextual science problems to be solved creatively. (6) Creatively Experiment Designing (CED), designing creative experiments. Students can formulate hypotheses, identify variables, create operational definitions of variables, design data tables, and design experimental procedures; and (7) Creatively Product Design (CPD), designing a product creatively. Students design a piece of equipment, and then explain the name of each section and its functions.

The smoothness points are obtained by counting all the correct answers given. The point of flexibility is obtained by calculating the number of approaches on the correct answer given. The frequency and percentage of each correct answer is calculated to get the originality points. If the probability response is less than 5%, it is given 2 points; 5-10% probability is given 1 point; for> 10%, is given 0 points. The creatively experiment designing score is the number of flexibility and originality points. Points of flexibility were obtained by calculating each correct function, it is given 1 points. Originality is given 1-5 points based on a holistic assessment (Hu & Adey, 2010; Siew, Chong, & Chin, 2014). Score of students' scientific creativity is the number of points earned, divided by the total of maximum points, multiplied by 4. The originality is determined based on the answer probability on each class and maximum score based on the highest post-test score of scientific creativity obtained by students in each class. Students' responsibility score is the number of scores obtained, divided by the total of maximum scores, multiplied by 4.

The choice of the test method relies on the fulfillment of normality assumptions for pre-test and post-test scores of students' scientific creativity and responsibility. Whether or not an increase in students' scientific creativity and responsibility is tested statistically with paired t-test (parametric) or Wilcoxon test (non-parametric), meanwhile, the magnitude of the increase level is calculated based on n-gain. The amount of increasing consistency (no difference) level among the four groups was tested by using ANOVA or Kruskal-Wallis test. This test is done with the help of IBM SPSS 16.0 software.

Result of Research

The learning outcomes of all groups related to the scientific creativity are presented in Figures 1 and Table 1. Gray bars represent the mean of pre-test and black bar scores represent the mean of post-test scores.

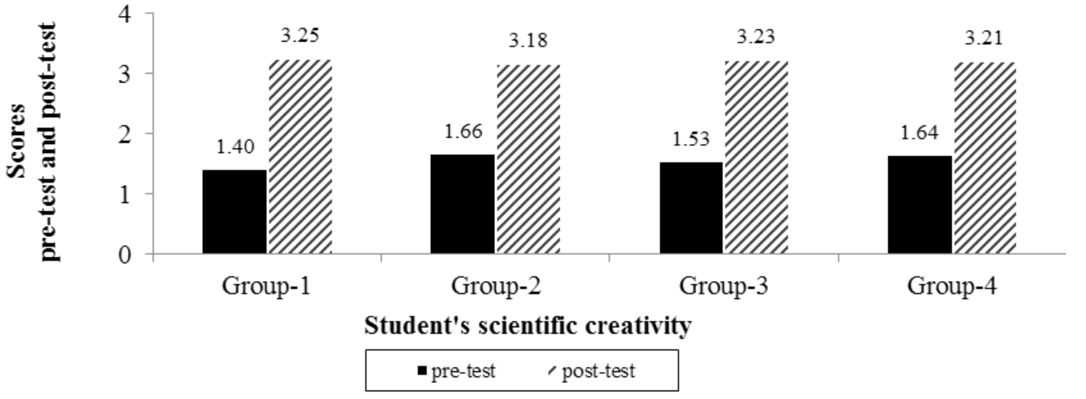

Figure 1: The average pre-test and post-test scores of scientific creativity in all groups.

Figure 1 shows the average post-test scores of scientific creativity in the Basic Physics course for all groups is greater than the pre-test score. The average pre-test, post-test, and n-gain scores associated with scientific creativity indicators for all groups are presented in detail in Table 1.

Table 1. The average pre-test, post-test, and n-gain scores of scientific creativity for all groups.

Group	Scores	Scientific Creativity Indicator						
		UU	PF	PI	SI	CED	SCPS	CPD
1 (Physics)	Pre-test	1.46	.67	1.23	1.10	.46	1.75	.71
	Post-test	2.48	2.55	3.00	2.22	2.67	3.35	1.79
	n-gain	**.40**	**.56**	**.64**	**.39**	**.62**	**.71**	**.33**
2 (Science)	Pre-test	1.53	.15	1.91	1.97	.72	1.15	1.40
	Post-test	2.85	2.37	2.64	2.64	2.39	2.09	2.26
	n-gain	**.53**	**.58**	**.35**	**.33**	**.51**	**.33**	**.33**
3 (Chemistry)	Pre-test	1.85	.16	1.56	1.65	.14	1.35	1.11
	Post-test	2.95	2.66	2.43	2.86	2.73	2.19	2.07
	n-gain	**.51**	**.65**	**.36**	**.52**	**.67**	**.32**	**.33**
4 (Biology)	Pre-test	1.83	.12	2.06	1.76	.20	1.33	1.21
	Post-test	2.74	2.44	2.64	2.65	2.77	2.17	2.45
	n-gain	**.42**	**.60**	**.30**	**.40**	**.68**	**.31**	**.45**

Note: UU = Unusual Uses, PF = Problem Finding, PI = Product Improvement, SI = Scientific Imagination, CED = Creatively Experiment Designing, SCPS = Science Creatively Problem Solving, CPD = Creatively Product Design.

The average pre-test and post-test scores of responsibility for all groups are presented in Figures 2 and Table 2.

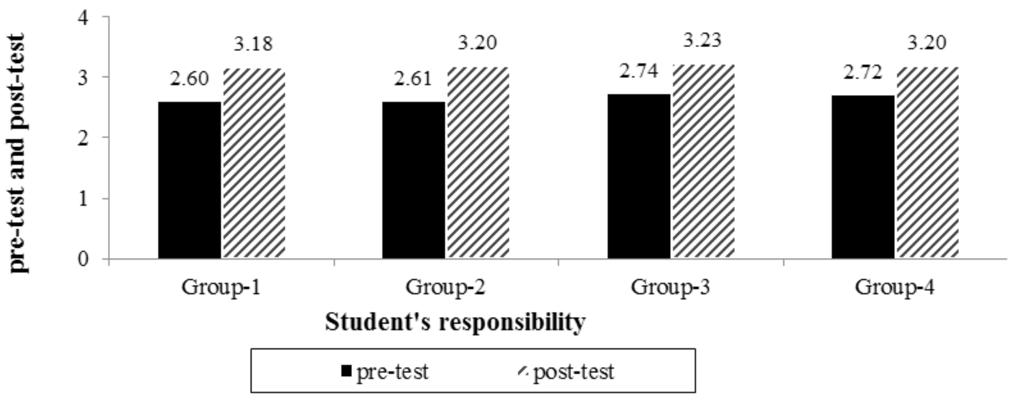

Figure 2: The average pre-test and post-test scores of responsibility in all groups.

Figure 2 shows that the average post-test score of responsibility for all groups is also greater than the pre-test score. The average pre-test, post-test, and n-gain scores associated with the responsibility indicators for all groups are presented in detail in Table 2.

Table 2. The average score of pre-test, post-test and n-gain of responsibility in all groups.

Group	Scores	Responsibility Indicator				
		Participation	Respecting	Cooperation	Leading	Delivering the Opinion
1 (Physics)	Pre-test	2.61	2.81	2.91	2.40	2.26
	Post-test	3.05	3.29	3.40	3.06	3.08
	n-gain	**.32**	**.40**	**.45**	**.41**	**.47**
2 (Science)	Pre-test	2.60	2.76	2.92	2.42	2.37
	Post-test	3.10	3.33	3.43	3.07	3.08
	n-gain	**.36**	**.46**	**.47**	**.41**	**.43**

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Group	Scores	Responsibility Indicator				
		Participation	Respecting	Cooperation	Leading	Delivering the Opinion
3 (Chemistry)	Pre-test	2.88	2.85	2.60	2.63	2.74
	Post-test	3.28	3.24	3.35	3.05	3.19
	n-gain	**.36**	**.34**	**.54**	**.31**	**.36**
4 (Biology)	Pre-test	2.72	2.81	2.75	2.79	2.54
	Post-test	3.12	3.26	3.47	3.18	2.99
	n-gain	**.31**	**.37**	**.58**	**.32**	**.31**

The average n-gain value of scientific creativity and responsibility for all groups is presented in Figure 3.

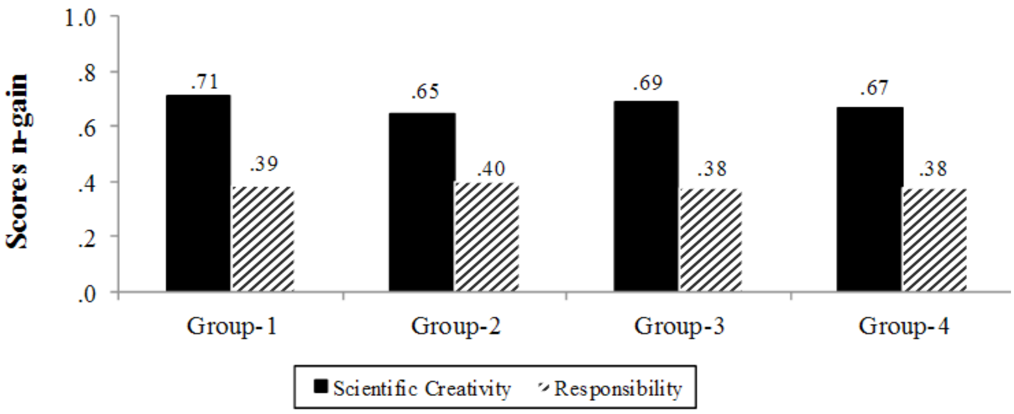

Figure 3: The average n-gain of scientific creativity and responsibility in all groups.

Figure 3 shows the average n-gain value of scientific creativity for group-1, group-2, group-3, and group-4 is respectively .71; .66; .69; and .67. The average n-gain value of scientific creativity for group-1 is in the high category, while the other groups are in the medium category. On the other hand, the average n-gain value of responsibility for the whole group is .39; .40; .38; and .38. Each group is in the medium category. The normality test of pre-test and post-test scores for the whole group was performed with one-sample Kolmogorov-Smirnov Z test by using IBM SPSS 16.0 software as shown in Table 3.

Table 3. The normalized pre-test and post-test of scientific creativity and responsibility for all groups.

Group	Test	N	Scientific creativity				Responsibility			
			Mean	Std. deviation	Asymp. sig. (2-tailed)	Normal distribution	Mean	Std. deviation	Asymp. sig. (2-tailed)	Normal distribution
1	Pre-test	36	1.40	.32	.06	Yes	2.60	.33	.20	Yes
	Post-test	36	3.25	.24	.06	Yes	3.18	.34	.20	Yes
2	Pre-test	36	1.66	.32	.20	Yes	2.61	.35	.03	No
	Post-test	36	3.18	.37	.20	Yes	3.20	.33	.20	Yes
3	Pre-test	36	1.53	.27	.20	Yes	2.74	.21	.20	Yes
	Post-test	36	3.23	.40	.01	No	3.23	.28	.20	Yes
4	Pre-test	36	1.64	.24	.15	Yes	2.72	.25	.06	Yes
	Post-test	36	3.21	.36	.20	Yes	3.20	.26	.20	Yes

Note: Group 1 (Physics); Group 2 (Science); Group 3 (Chemistry); Group 4 (Biology)

Table 3 shows that pre-test and post-test scores of students' creativity and responsibility are distributed normally for the whole group, except group-3 which is not distributed normally in post-test scores of scientific creativity and group 2 is not distributed normally in pre- test responsibility. Therefore, the impact of learning with the CRBT model on improving scientific creativity and responsibility for the whole group by using paired t-test, except for students' creativity for group-3 and responsibility for the group 2 which are not distributed normally were analyzed by using the Wilcoxon test. The results of paired t-test and Wilcoxon test are presented in Table 4 and Table 5.

Table 4. Paired t-test and Wilcoxon test result of scientific creativity for all groups.

Group	N	Paired t-test					Wilcoxon test	
		Mean	Std. error mean	t	df	p	Z	p
1	36	-1.88	.06	-28.53	35	< .001		
2	36	-1.52	.06	-22.49	35	< .001		
3	36						-5.23	< .001
4	36	-1.57	.05	-26.95	35	< .001		

*Note: Group 1 (Physics); Group 2 (Science); Group 3 (Chemistry); Group 4 (Biology); *p < .05 (2-tailed)*

Table 4 shows that the average of scientific creativity for group 1, 2, and 4 is 1.88; 1.52; 1.57 and has degrees of freedom (df) = 35, t score gives t value = -8.53; t = -22.49; and t = -26.95 for group-1, group-2, and group-3. The score is significant, because $p < .05$. Likewise, in group-3 that Z gives the value -5.23 with significance level $p < .05$ so it is significant. Since the results of the calculations are negatively valuable, it is clear that there is an increase in scientific creativity after the application of learning with CRBT model for all groups.

Table 5. Paired t-test and Wilcoxon test results of responsibility for all groups.

Group	N	Paired t-test					Wilcoxon test	
		Mean	Std. error mean	t	df	p	Z	p
1	36	-.57	.06	-8.59	35	< .001		
2	36						-5.03	< .001
3	36	-.48	.04	-9.91	35	< .001		
4	36	-.48	.03	-14.83	35	< .001		

Table 5 shows the average of responsibility for groups 1, 3, and 4 are .57; .48; .48 and the t score gives t value = -8.59; t = -9.91; and t = -14.83 for degrees of freedom (df) = 35 in groups-1, group-3, and group-4. In addition, the Z score gives a value of -5.03 for group-2. Each score is considered significant, because $p < .05$. Therefore, the t result of the calculation is negative, so it shows there is an increase in student responsibility after the application of CRBT model for all groups. Furthermore, the consistency of the impact from CRBT model application on the improvement of scientific creativity is analyzed by using ANOVA and the responsibility is analyzed by using Kruskal-Wallis test after the assumption of normality and homogeneity of variance, it is shown in Table 6 and Table 7.

Table 6. Conclusions of ANOVA test of scientific creativity in all groups.

	Sum of squares	df	Mean square	F	p
Between groups	.06	3	.02	1.12	.34
Within groups	2.69	140	.01		
Total	2.75	143			

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Table 7. **Conclusions of Kruskal-Wallis test of responsibility in all groups.**

	N	Chi square	df	p
Group 1 (physics), group 2 (science), group 3 (chemistry), group 4 (biology)	144	.43	3	.93

Table 6 shows that F arithmetic gives $F = 1.121 < F_{table}$ (3,140) = 1.67 with significance level $p = .34 > .05$. In addition, Table 7 shows the significance value $p = .93 > .05$. This clearly indicates that there is no difference in the increase of scientific creativity as well as the responsibility of the students after the application of Basic Physics learning with CRBT model for all groups.

Based on the data analysis above, it can be concluded that: (1) there is a significant increase (statistically) at the level of significance, $\alpha = 5\%$; (2) the level of increase determined by the normalized gain value, (n-gain) is moderate; and (3) the average level of improvement in the four groups did not differ significantly. In the meantime, the data of interview result with students about students' scientific creativity and responsibility are summarized in Table 8.

Table 8. **Summary of Interview Results with Students about Students' Scientific Creativity and Responsibility**

Student Scientific Creativity

"All this time, students have difficulty in recognizing variables from physics problem, theory, and symbol in the presented physics formulas; the selection of variables is less precise; difficult in distinguishing manipulation variables and response variables; difficult in connecting variables written in the formula with other variables. Students are lack of knowledge about physics problems in real life. For example: when asked to write down as many as possible the way to channel the source of electricity from the State-Owned Company (PLN) to consumers who require different voltage sources. Students feel less knowledge about PLN, distribution process, equipment used, and others. Similarly, when students are asked to design a nail mining tool to overcome the rampant of nail mines in the streets of the capital city Jakarta, and showing the names of each section and its functions. Although students felt that they had studied magnetic electrical materials, they felt that they are lack of sufficient knowledge of nail mines, nail mine components, how they worked, etc."

Student's Responsibility

"Students feel often in gaining knowledge about responsibility through socialization at the level of study program, faculty, and university, as well as attending seminars with the theme of character-based learning. Students feel that they understand what responsibility is, the characteristics of responsible people, and the importance of responsibility for themselves, society, nation and state. However, the students feel confuse and are not yet accustomed to implementing responsibility for being successful in their own learning process. "

Table 8 shows that students find it difficult to recognize variables on physics problem, theory, and symbol written in the formula; the selection of variables is less precise; difficult in distinguishing between manipulation variables and response variables; and difficult in connecting variables in formulas with other variables. Students are still confused and unaccustomed to apply responsibility for being successful in their own learning process. Scientific investigation activities and scientific tasks are more effective when starting with asking the best questions (deserve to be targeted and focused experiments), giving rise to the responsibility for putting together experiments and developing possible hypotheses, and ultimately responsible for getting the most accurate and useful results. Responsibility is required to support the success of scientific investigation and scientific creativity tasks during basic physics courses.

Discussion

A more complete explanation concerning the effectiveness of the CRBT model for enhancing scientific creativity and student responsibility is described as follows. The effectiveness of the CRBT model on improving students' scientific creativity in physics learning can be seen from: (1) an increase in pre-test and post-test scores, (2) n-gain creativity value, and (3) (consistent), as shown in Figure 1, Table 1, and Table 4. Before the CRBT model is applied; students less master the scientific creativity, average score of students is under the standard score (minimum score 2.00 in score range 1-4), that is the average score of scientific creativity for group-1, group-2, group-3, and group-4 respectively are 1.40; 1.66; 1.53; and 1.64. All this time, students are not used to solve unusual uses, problem finding, product improvement, scientific imagination, creatively experiment designing, creatively science problem solving, and creatively product design. The data collected through interviews with students in Table 8 indicates that students still have difficulty in recognizing the variables of physics problems, theory, and symbol written in the formula; choose less precise variable; difficult in distinguishing manipulation variables and response variables; and difficult in connecting variables in formulas with other variables. The underlying causes of scientific creativity are in accordance with 'functional theory' (Solso, Maclin, & Maclin, 2008) that students tend to see things based on the usual usefulness and difficult in accepting new perspectives that are actually needed in problem solving. This is supported by Mueller, Melwani, & Goncalo (2012) that someone is born creative, but the barriers to creativity often interfere with the ability to recognize creative ideas.

Conversely, after the CRBT model was applied to the Basic Physics course, the mastery of students' scientific creativity rises above average and becomes high; the average score of scientific creativity for groups-1, group-2, group-3, and group-4 respectively to 3.25; 3.28; 3.23; and 3.21 (well beyond the minimum score of 2.00 in the 1-4 score range). The increase in scientific creativity is allegedly influenced by the role of the student's responsibility to be a creative person as the scenario in phase 1 of the CRBT model: Generating creative responsibility. The creative person is always happy in identifying problems, conveying creative ideas, trying to overcome creativity barriers, taking logical risks, accepting differences, having self-confidence, and not being satisfied quickly (Sternberg, 2009). In line with the findings of Voinea & Palasan (2014) that lecturers are able to help students realize their roles and responsibilities in the learning process by becoming study partners, involving them in scientific investigations and scientific creativity tasks, and fostering a positive attitude in learning. The importance of this responsibility is supported by the theory of metacognitive skills (Moreno, 2010) that the responsibility (self-awareness) as a student to monitor his own learning strategies and knowledge can increase the transfer of what is learned into new situations. Another support from locus control theory (Slavin, 2011) that personality traits (self-awareness) determine whether students are willing to link responsibility for their own failure or success to internal and external factors. Attempts to realize responsible behavior depend on their self-awareness in learning (Dementiy & Grogoleva, 2016; Eliasa, 2014). Responsibility reflects the motivation of learning on the one hand and encourages the development of scientific creativity on the other (Blascova, 2014). Therefore, lecturers must create situations that meet the need for autonomy, competence and sense of belonging to enhance positive motivation in physics learning (Yang & Dong, 2017). Based on the above description, the implementation of phase 1 CRBT model can generate confidence and role of student's responsibility to try to be successful in learning process.

The increase of scientific creativity score in all groups was significant and did not differ (consistent) at the 5% significance level with n-gain of .71 for group-1; .65 for group-2; .69 for group-3; and .67 for group-4. This means that there is an increase in students' scientific creativity after the application of Basic Physics teaching with CRBT model. Increased scientific creativity is supported by the availability of creative learning needs as suggested in phase 2 of the CRBT model: Organizing creative learning needs. Lecturers have been able to facilitate the need for scientific investigation, scientific creativity tasks, and an autonomy-based learning environment well. These creative learning needs are presented clearly and attractively in MFIs and Textbooks to inspire students to take on their responsibilities ranging from planning, implementation, and evaluation throughout the learning process. Creative learning needs include the availability of quality trap unit of lectures devices, laboratory equipment, and ICT media and their supporters. In addition, the roles of creative and accountable lecturers are able to create an investigative-based learning environment in a free, open, democratic and positive atmosphere. This is supported by the theory of reciprocal causation model (Moreno, 2010) that students become more creative when the environment encourages them to learn creatively and think independently. Another theory is advanced that organizers (Slavin, 2011) directing students to the material to be learned and

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

helping recall related information could help to unify new information. The theory is in line with Article 13 Permenristekdikti Number 44 Year 2015 that the learning process takes place in the form of interaction between lecturers, students, and learning resources in a particular learning environment. Based on the above explanation, the success of lecturers in facilitating the teaching materials, learning environment, and social interaction can encourage the reconstruction of knowledge, responsibility habituation, and the development of scientific creativity well. Based on the above description, the implementation of phase 2 of the CRBT model is able to facilitate the creative learning environment that is necessary to carry out scientific investigations and scientific creativity tasks. In other words, the success of phase 2 will determine the smoothness of the next phases.

The level of scientific creativity improvement for all groups due to the application of learning with the CRBT model is significant at 5% real level and consistent in the medium category. It is suspected because a lecture device that has been valid supports it. In addition, the increase in scientific creativity is strongly influenced by the success of phase 3 CRBT model: Guiding group investigation as the core phase of the CRBT model. Lecturers are able to facilitate students by presenting ill-defined problems; then guide them to make the problem formulation as much as possible; choosing one of the problem formulas for disposal; planning the experiment creatively (formulating hypotheses, identifying variables, making operational definitions of variables, designing data tables, designing experimental procedures); and solve problems creatively (collect data through self-designed experiments and review references, analyze data and draw conclusions). The importance of group investigation according to the John Dewey flow of problem solving (Arends, 2012) that the class should be a laboratory for investigation and solving real-life problems. Hypothesis Hu & Adey (2010) states that scientific creativity is emphasized in creative science experiments, finding problems and solving problems creatively, and science activities creatively. Another support is the theory of complex cognitive processes (Eggen & Kauchak, 2013) that creativity is an essential component of solving ill-defined problems. In addition, constructivism theory (Moreno, 2010) explains that students can construct their knowledge through personal experience with others and the environment. The theories are reinforced by Ayas & Sak (2014) that scientific creativity involves the interaction of hypothesis generalization, experimental design, and evaluation of evidence. Based on the above description, the implementation of phase 3 CRBT model is able to develop the role of student's responsibility in the success of scientific investigation through problem finding, creatively experiment designing, and creatively science problem solving.

The increased scientific creativity is also strongly influenced by the tasks of scientific creativity in phase 4 of the CRBT model: Establishing responsibility for demonstrating scientific creativity as well as the core phase of the CRBT model. Students have been able to take responsibility for exploiting the various impacts of the science and technology development, finding various alternative solutions, and communicating scientifically. This is supported by the theory of complex cognitive processes (Moreno, 2010) that creativity is the ability to generate new ideas, incorporate ideas in new ways, or solve problems uniquely. Complex cognitive processes are required to use or transform prior knowledge and skills into a creative product (Eggen & Kauchak, 2013). In addition, it is supported by the theory of communication skills (Moreno, 2010) that effective lecturers are able to speak clearly, reward students, interpret student behavior, and solve class problems constructively. The importance of scientific communication is supported by phase 5: evaluation and reflection. Lecturers are able to involve students in assessing their own learning processes and outcomes, learning from the process, and applying what they learn to improve their actions in the future. The involvement of students in planning, implementing and evaluating the learning process contributes significantly to the achievement of responsibility and learning outcomes (Yesil, 2013). This is in line with Article 11 Permenritekdikti No. 44 Year 2015 that the achievement of higher education graduate's competence is achieved through a learning process that prioritizes the development of creativity and responsibility (personality, independence) in searching and finding knowledge. Based on the above description, the implementation of phases 4 and 5 CRBT model is able to establish the role of student responsibility in developing scientific creativity through decision-making process and solving real-life problems, and scientific communication. Students are able to produce scientific creativity products in the form of scientific creativity test items along with alternative solutions.

The Increased student responsibility due to the implementation of CRBT model can be seen from: (1) the increase of pre-test and post-test score of student's responsibility; (2) the value of n-gain of student's responsibility; and (3) the improvement of the four groups towards the consistent student's responsibility shown in Figure 2, Table 2, and Table 6. Before the CRBT model was applied, the average score of responsibility for group-1, group-2, 3, and group-4 are respectively 2.60; 2.61; 2.74; and 2.72. This indicates that the students already understand about responsibility well, because the average score of responsibility for each group exceeds the minimum criterion of 2.33 in the range of 1-4 scores. Similarly, an indicator of responsibility in terms of participating, respecting others, working together, leading, and expressing opinions are also in good category. The factors responsible for student responsibility have been good because the development of responsibility has become part of the mental revolution proclaimed by Mr. Joko Widodo, President of the Republic of Indonesia in the period of 2014-2019. This is also part of the vision and mission of physics education in Indonesia. Character-based learning socialization (including responsibility) is often done. National seminar with the similar theme is also often done. However, unfortunately learning responsibility through socialization or seminars without being integrated in the learning process provides opportunities for mock participation. The mock participation theory explains the situation in which the student feels involved in the assignment but is not involved in the learning process (Slavin, 2011). This is consistent with the result of previous research that the learning of responsibility has not been integrated in the learning process in the classroom, so that the student understands the responsibility only as knowledge (In & Thongperm, 2014; Suyidno, Nur, Yuanita, Sunarti, & Prahani, 2016). This is reinforced by the results of the researcher's interview with the students as shown in Table 8 that the student feels and understands the sense of responsibility; the characteristics of responsible persons; and the importance of responsibility for oneself, the community, and the state. Particular attention is given to students in order to accustom them to internalize their responsibility role for being successful in their own learning process. It can be seen in Figure 2 that the impact of applying CRBT model in elementary physics course was able to increase the responsibility of the better students to be better in all groups. The increase of responsibility scores for all groups was significant and consistent at the 5% significance level with moderate n-gain. Reinforced by Table 5 and Table 7 that there is an impact on the implementation of the CRBT model on improving student's responsibility. The magnitude impact of the CRBT model on increasing responsibility for all groups is consistently significant at a real 5% level and moderate category. Based on the above description, the implementation of CRBT model not only increases the knowledge of student's responsibility, but also the application in improving the quality of the process and the learning outcomes.

The development of student's responsibility has become the characteristic of every phase in the CRBT model. In line with the English & Kitsantas (2013) recommendation that the CRBT model is developed as an innovation of the PBL, LTT, project-based SCL model involves the role of student responsibility for being success in their learning process. The lecturer guides the students to realize their responsibilities in the learning process by becoming a learning partner, involving in group investigation, scientific creativity tasks, and cultivating a positive attitude in learning (Voinea & Palasan, 2014). Students are able to participate, respect others, work together, lead, and express opinions during the learning process as well as possible (Escarti, Wright, Pascual, & Gutierrez, 2015). This is supported by the theory of metacognitive skills (Moreno, 2010) that responsibility (self-awareness) of an active student in monitoring his own learning strategies and knowledge can increase the transfer of what is learned into new situations. In line with the findings of Zaripova & Kalatskaya (2016) that shaping scientific responsibility and creativity does not mean equipping students with ready-made motives and goals. Instead, students are conditioned in situations and conditions where they can internalize the roles of scientific responsibility and creativity in physics learning activities. This is consistent with the purpose of physics education to create the conception of physics as an important part of human culture, where the product of scientific creativity can be beneficial to people's lives (Bilek, 2016). Based on the above description, the application of CRBT model is able to facilitate students to connect the complexity between physics and technology material on the one hand, and responsibility to society on the other.

The improved scientific creativity and responsibility are also inseparable from the support of skills training in the science process before the application of the CRBT model. Science process skill training can facilitate lecturers in carrying out the phases of the CRBT model especially in the early meetings. This can be seen from group investigation activities and students' scientific creativity tasks at meetings 1-3 that often exceed the specified time allocated, but at 4-6 meetings, they are increasingly accustomed to develop their own scientific creativity and responsibility. Scientific creativity includes sensitivity to problems, identifying problems, formulating hypotheses, testing hypotheses, and communicating results (Torrance, 2013). Understanding the skills of the science process makes students understand how to move science, carry out investigations, and complete the tasks of scientific creativity well (Demenity & Grogoleva, 2016). Reinforced the results of previous research that scientific creativity has a strong and significant correlation with the skills of the scientific process (Aktamis & Ergin, 2008; Dhir, 2014; Ozdemir & Dikici, 2017; Farsakoglu, Sahin & Karsli, 2012; Hu & Adey, 2010; Hu, Wu, Jia,

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Yi, Duan, & Meyer, 2103; Mirzae, Hamidi, & Anaraki, 2009; Siew, Chong, & Chin, 2014). In addition, the skills of the science process further could strengthen the role of student's responsibility in their own learning process (Karamustafaoglu, 2011; Zeidan & Jayosi, 2015). The above explanation indicates that the science process skill makes it easier for students to carry out scientific experiments, complete the tasks of scientific creativity, and improve their responsibility to strive for being successful in learning.

The main strength of the CRBT model is that it is trying to integrate scientific process skill, scientific creativity, and comprehensive responsibilities in physics learning. Scientific process skills are basic skills for mastering physics (Prayitno, Corebima, Susilo, Zubaidah, & Ramli, 2017). Scientific process skill underlies the thinking process in science activities, scientific investigations, and scientific creativity tasks. Scientific creativity produces creative ideas and technology products to solve life's problems. However, this scientific creativity is like a double-edged sword, on the one hand can lead to creation, and on the other hand can lead to destruction. Therefore, responsibility as a personality trait is needed to bring the scientific creativity toward a positive way in various areas of life (Ozdemir & Dikici, 2017; Sternberg, 2009; Velev, 2004). Another impact of applying CRBT model in basic physics courses is the improvement of scientific knowledge, science process skills, and student character development. This is in accordance with the hypothesis of Hu & Adey (2010) that scientific creativity depends on scientific knowledge and science process skills. Responsibility as a personality trait indirectly underlies the development of other student's characters (e.g. discipline, independence, honesty, hard work, curiosity, and never give up). An investigative-based learning environment that utilizes laboratory equipment, ICT media, and various reference sources indirectly equips students with ICT skills. ICT-based media investigations make it easier for students to make decisions and solve problems effectively (Sitti, Sooperak, & Sompong, 2013).

Conclusions

The results of this research indicate that the CRBT model is effective to improve the scientific creativity and responsibility of the students in the Study Program: Physics, Science, Chemistry and Biology based on: (1) there is a significant increase in scientific creativity and student responsibility after using CRBT model at $\alpha = 5\%$; (2) the n-gain value of scientific creativity and responsibility reside in the medium category; and (3) the n-gain average for students' scientific creativity and responsibility in all groups is not different (consistent). Development of responsibility, scientific process skills, and scientific creativity through the CRBT model is expected to facilitate students to achieve their success in the future. Students have been accustomed to creative imagination in producing unusual new ideas and thinking of unique solutions to problem solving. Students have been facing a challenging future, understanding the world they live in, adapting to rapid society change, making scientific discoveries and technological innovations to achieve success. The implication of this research is that CRBT model can be used as an alternative to overcome the low students' scientific creativity and responsibility in basic physics course. To strengthen the result of this research, it is necessary to do further research in various education levels and countries.

Acknowledgements

The author's gratitude goes to the Ministry of Research, Technology and Higher Education for funding the Research (SK Number: 024 / SP2H / LT / DRPM / II / 2016 dated 17 February 2016). Likewise, the author's gratitude goes to the University of Lambung Mangkurat and the State University of Surabaya that have provided research opportunities.

References

ADB. (2014). *Creative productivity index: Analyzing creativity and innovation in Asia. A report by the economist intelligence unit for the Asian Development Bank August 2014.* The Economist Intelligence Unit Ltd. and Asian Development Bank.

Aktamis, H., & Ergin, O. (2008). The effect scientific process skills education on student's scientific creativity, science attitudes, and academic achievement. *Asia-Pacific Forum on Science learning and Teaching, 9* (1), 1-21.

Arends, R. I. (2012). *Learning to teach*. New York: Mc. Graw-Hill.

Ayas, M. B., & Sak, U. (2014). Objective measure of scientific creativity: Psychometric validity of the creative scientific ability test. *Thinking Skills and Creativity, 13*, 195–205.
Bakir, S., & Oztekin, E. (2014). Creative thinking levels of preservice science teachers in terms of different variables. *Journal of Baltic Science Education*, *13* (2), 231-242.
Bilek, M. (2016). Question for current science education: Virtual or real? *Journal of Baltic Science Education*, *15* (2), 136-139.
Blascova, M. (2014). Influencing academic motivation, responsibility and creativity. *Procedia - Social and Behavioral Sciences, 159*, 415-425.
Dementiy, L. I., & Grogoleva, O. Y. (2016). The structure of responsibility of preschool and primary school age children. *Procedia-Social and Behavioral Sciences*, *233* (1), 372-376.
Dhir, T. (2014). Problem solving ability and science process skills as the influential factors of scientific creativity. *International Journal of Research Pedagogy and Technology in Education Movement Sciences, 2* (4), 11-17.
Eggen, P. D., & Kauchak, D. P. (2013). *Educational psychology:* Windows on classrooms (9th edition). New Jersey: Pearson.
Eliasa, E. I. (2014). Increasing values of teamwork and responsibility of the students through games: Integrating education character in lectures. *Procedia-Social and Behavioral Sciences*, *123*, 196-203.
English, M. C. & Kitsantas, A. (2013). Supporting student self-regulated learning in problem-and project-based learning. *Interdisciplinary Journal of Problem Based Learning, 7* (2), 46-54.
Escarti, A., Wright, P. M., Pascual, C., & Gutierrez, M. (2015). Tool for assessing responsibility-based education (Tare) 2.0: Instrument revisions, inter-rater reliability, and correlations between observed teaching strategies and student behaviors. *Universal Journal of Psychology, 3* (2), 55-63.
Farsakoglu, O. M., Sahin, C., & Karsli, F. (2012). Comparing science process skills of prospective science teachers: A cross-sectional study. *Asia-Pacific Forum on Science Learning and Teaching, 13* (1), 1-22.
Fraenkel, J. R., & Wallen N. E. (2012). *How to design and evaluate research in education.* Boston: Mc Graw-Hill, Higher Education.
Gorghiu, G., Draghicescu, L. M., Cristea, S., Patrescu, M., & Gorghiu, L. M. (2015). Problem-based learning: An efficient learning strategy in the science lessons context. *Procedia-Social and Behavioral Sciences, 191,* 1865-187.
Greiff, S., Wustenberg, S., Csapo, B., Demetriou, A., Hautamaki, A., Graesser, A. C., & Martin, R. (2014). Domain-general problem-solving skills and education in the 21st century. *Educational Research Review, 13* (1), 74-83.
Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American Journal of Physics, 66* (1), 64-74.
Hu, W., & Adey, P. (2010). A scientific creativity test for secondary school students. *International Journal of Science Education, 24* (4), 389-403.
Hu, W., Shi, Q. Z., Han, Q., Wang, X., & Adey, P. (2010). Creative scientific problem finding and its developmental trend. *Creativity Research Journal*, *22* (1), 1-7.
Hu, W., Wu, B., Jia, X., Yi, X., Duan, C., & Meyer, W. (2013). Increasing student's scientific creativity: The "learn to think" intervention program. *The Journal of Creative Behavior, 47* (1), 3-21.
In, K. N., & Thongperm, O. (2014). Teaching of science process skills in Thai contexts: Status, supports and obstacles. *Procedia-Social and Behavioral Sciences*, *141* (1), 1324-1329.
Jatmiko, B., Widodo, W., Martini, Budiyanto, M., Wicaksono, I., & Pandiangan, P. (2016). Effectiveness of the INQF-based learning on a general physics for improving student's learning outcomes. *Journal of Baltic Science Education*, *15* (4), 441-451.
Kadayifci, K. (2017). Barriers to students' creative evaluation of unexpected experimental findings. *Journal of Baltic Science Education*, *16* (3), 414-428.
Kang, D., Park, J., & Hong, H. (2015). Changes in the number of ideas depending on time when conducting scientific creativity activities. *Journal of Baltic Science Education*, *14* (4), 448-459.
Karamustafaoglu, S. (2011). Improving the science process skills ability of science student teachers using i diagrams. *Eurasian of Journal Physics and Chemistry Education*, *3* (1), 26-38.
Minister of Education and Culture. (2013). Regulation of the minister of education and culture number 73 of 2013 on the application of higher education INQF. Jakarta: Ministry of Education and Culture.
Minister of Research, Technology and Higher Education. (2015). Regulation of the minister of research, technology and higher education number 44, 2015 for national standards of higher education. Jakarta: Ministry of Research, Technology and Higher Education.
Mirzae, R. A., Hamidi, F., & Anaraki, A. (2009). A study on the effect of science activities on fostering creativity in preschool children. *Journal of Turkish Science Education, 6* (3), 81-9.
Moreno, R. (2010). *Educational psychology*. New Mexico. John Wiley & Sons, Inc.
Moutinho, S., Torres, Joana, T., Fernandez, I., & Vasconcelos, C. (2015). Problem-based learning and nature of science: A study with science teachers. *Procedia-Social and Behavioral Sciences, 191*, 1871-1875.
Mueller, J. S., Melwani, S., & Goncalo, J. A. (2012). The bias against creativity: Why people desire but reject creative ideas. *Psychological Science, 23* (1), 13-17.
Nariman, N., & Chrispeels, J. (2015). PBL in the era of reform standards: Challenges and benefits perceived by teachers in one elementary school. *Interdisciplinary Journal of Problem-Based Learning, 10* (1), 1-16.
OECD. (2014). *PISA 2012 results: Creative problem solving: Student's skills in tackling real-life problems (Volume V), PISA*. Publishing: OECD.

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Ozdemir, G., & Dikici, A. (2017). Relationships between scientific process skills and scientific creativity: Mediating role of nature of science knowledge. *Journal of Education in Science, Environment and Health, 3* (1), 52-68.

Park, J. (2012). Developing the format and samples of teaching materials for scientific creativity in the ordinary science curriculum-Including teachers' practice and reflection. *Journal of Korean Association for Science Education*, *32* (3), 446-466.

Prayitno, B. A., Corebima, D., Susilo, H., Zubaidah, S., & Ramli, M. (2017). Closing the science process skills gap between students with high and low level academic achievement. *Journal of Baltic Science Education, 16* (2), 266-277.

Raj, H., & Saxena, D. R. (2016). Scientific creativity: A review of researches. *European Academic Research, 4,* 1122-1138.

Rietzschel, E. F., Bernard A. N., & Wolfgang, S. (2010). The selection of creative ideas after individual idea generation: Choosing between creativity and effect. *British Journal of Psychology, 101* (1), 47-68.

Rohkman, Syaifudin, & Yuliati. (2014). Character education for golden generation 2045 (national character building for Indonesian golden years). *Procedia-Social and Behavioral Sciences*, *141(1)*, 1161-1165.

Rolina, N. (2014). Developing responsibility character for university student in ECE through project method. *Procedia - Social and Behavioral Sciences, 123*(1), 170-174.

Saliceti, F. (2015). Educate for creativity: New educational strategies. *Procedia-Social and Behavioral Sciences, 197* (1), 1174-1178.

Sevilla, C. G., Ochave, J. A., Punsalan, T. G., Regala, B. P., & Uriarte, G. G. (1984). *An introduction to research methods*. Quezon City: Rex Printing Company.

Siew, N. M., Chong, C. L., & Chin, K. O. (2014). Developing a scientific creativity test for fifth graders. *Problems of Education in the 21st Century, 62* (1), 109-123.

Sitti, S., Sooperak, S., & Sompong, N. (2013). Development of instructional model based on connectivism learning theory to enhance problem-solving skill in ICT for daily life of higher education students. *Procedia - Social and Behavioral Sciences*, *103* (1), 315-322.

Slavin, R. E. (2011). *Educational psychology, theory and practice*. Boston: Pearson Education.

Solso, R. L., MacLin, O. H., & MacLin, M. K. (2008). *Cognitive psychology, 8th edition*. Boston: Pearson Education.

Sternberg, R. J. (2009). Academic intelligence is not enough WICS: An expanded model for effective practice in school and in later life. *Mosakowski Institute for Public Enterprise.* Paper 4. Retrieved 04/07/2016, from http://commons.clarku.edu/mosakowskiinstitute/4.

Susantini, E., Isnawati, & Lisdiana, L. (2016). Effectiveness of genetics student worksheet to improve creative thinking skills of teacher candidate students. *Journal of Science Education*, *2* (17), 74-79.

Susantini, E., Lisdiana, L., Isnawati, Al Haq, A. T., & Trimulyono, G. (2017). Designing easy DNA extraction: Teaching creativity through laboratory practice. *Biochemistry and Molecular Biology Education, 45* (3), 216-225.

Suseno, N. (2010). Kendala penerapan inkuiri dalam perkuliahan listrik-magnet di LPTK [Constraints of inquiry implementation in magnet-electric course at LPTK]. *Jurnal Pengajaran MIPA*, *15*(2), 95-102.

Suyidno & Nur, M. (2015). Pemahaman kreativitas ilmiah mahasiswa dalam pembelajaran kreatif pada matakuliah fisika dasar [Understanding of students' scientific creativity in creative learning at basic physics courses]. *Prosiding Seminar Nasional Program Studi Pendidikan Sains Pascasarjana Universitas Negeri Surabaya*, 24 Januari 2015, 1361-1366.

Suyidno, Dewantara, D., Nur, M., & Yuanita, L. (2017). Maximize student's scientific process skill within creatively product designing: Creative responsibility based learning. *Advances in Social Science, Education and Humanities Research*, *100*, 98-103.

Suyidno, Nur, M., & Yuanita, L. (2016). Keterlaksanaan model Scientific Creativity Learning (SCL) untuk melatihkan kreativitas ilmiah mahasiswa dalam pembelajaran fisika [Accomplishment of Scientific Creativity Learning (SCL) model to train students' scientific creativity in physics learning]. *Prosiding Seminar Nasional Masif II FMIPATI Universitas PGRI Semarang*, 3 September 2016, 263-268.

Suyidno, Nur, M., Yuanita, L., & Prahani, B. K. (2017). Validity of creative responsibility based learning: An innovative physics learning to prepare the generation of creative and responsibility. *Journal of Research & Method in Education*, *7* (1), 56-61.

Suyidno, Nur, M., Yuanita, L., Sunarti, T., & Prahani, B. K. (2016). Student's responsibilites department PMIPA of Lambung Mangkurat University in learning physics. *Jurnal Vidya Karya FKIP Universitas Lambung Mangkurat, 2,* 46-59.

Torrance, E. P. (2013). *Scientific views of creativity and factors affecting its growth*. The MIT Press and American Academy of Arts & Sciences are collaborating with JSTOR to digitize, preserve and extend access to Daedalus. Retrieved 05/07/2016, from https://www.cc.gatech.edu/classes/AY2013/cs7601.../Torrance-Viewsofcreativity.pdf.

Velev, V. (2004). Digital creativity: Advantages, problems, responsibilities. *International Journal Information Theories & Applications*, *11*, 60-67.

Voinea, M., & Palasan, T. (2014). Teachers' professional identity in the 21st century Romania. *Procedia-Social and Behavioral Sciences*, *128*, 361–365.

Wibowo, F. C., & Suhandi, A. (2013). Penerapan model Science Creative Learning (SCL) fisika berbasis proyek untuk meningkatkan hasil belajar kognitif dan keterampilan berpikir kreatif [Implementation of Science Creative Learning (SCL) model for project-based physics to improve cognitive learning outcomes and creative thinking skills]. *Jurnal Pendidikan IPA Indonesia, 2* (1), 67-75.

Yang, C. B., & Dong, M. K. (2017). A study of the correlation between teachers' teaching styles and students' participation motivation in the physical education. *Journal of Baltic Science Education*, *16* (2), 199-206.

Yesil, R. (2013). The evaluation of responsibility education strategies of primary school teachers. *Procedia-Social and Behavioral Sciences*, *106* (1), 2775- 2787.
Zakar, Z., & Baykara, H. (2014). Inquiry-based laboratory practices in a science teacher training program. *Eurasia Journal of Mathematics, Science and Technology Education, 10* (2), 173-183.
Zaripova, A. R., & Kalatskaya, N. N. (2016). The development of teenagers' responsible and creative attitude to learning activity. *IEJME-Mathematics Education*, *11* (4), 633-645.
Zeidan, A. F., & Jayosi, M. R. (2015). Science process skills and attitudes toward science among Palestinian. *World Journal of Education, 5* (1), 13-24.

Received: *October 03, 2017*   Accepted: *February 10, 2018*

Suyidno	Doctor, Researcher, Universitas Lambung Mangkurat (Lambung Mangkurat University), Jl. Brigjend. H. Hasan Basry Kayutangi, Banjarmasin 70124, Indonesia. E-mail: Suyidno_pfis@unlam.ac.id Website: http://www.unlam.ac.id
Mohamad Nur	Professor, Researcher, Universitas Negeri Surabaya (State University of Surabaya), Jl. Ketintang Surabaya 60231, Indonesia. E-mail: psmsunesa@yahoo.co.id Website: http://www.unesa.ac.id
Leny Yuanita	Professor, Researcher, Universitas Negeri Surabaya (State University of Surabaya), Jl. Ketintang Surabaya 60231, Indonesia. E-mail: lenyyuanita@unesa.ac.id Website: http://www.unesa.ac.id
Binar Kurnia Prahani	Doctor, Researcher, Universitas Negeri Surabaya (State University of Surabaya), Jl. Ketintang Surabaya 60231, Indonesia. E-mail: binarprahani@gmail.com Website: http://www.unesa.ac.id
Budi Jatmiko *(Corresponding author)*	Professor, Researcher, Universitas Negeri Surabaya (State University of Surabaya), Jl. Ketintang Surabaya 60231, Indonesia. E-mail: budijatmiko@unesa.ac.id Website: http://www.unesa.ac.id