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Research Article

Increasing Students' Responsibility and Scientific Creativity through Creative Responsibility Based Learning

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Abstract

Scientific creativity and responsibility are believed to be key factors for overcoming increasingly complex real-life problems faced by students; but both competencies are not trained in school. Therefore, this research aims to describe the effectiveness of creative responsibility based learning (CRBL) to increase student's responsibility and scientific creativity on physics learning in senior high school. This research used one group pretest-posttest design involving 66 students of two senior high schools in Banjarmasin, South Kalimantan, Indonesia. The data collection was conducted by using responsibility observation emphasizing on participatory, cooperation, delivering an opinion, and leadership. Additionally, data were gained through scientific creativity test emphasizing on problem finding, product improvement, scientific imagination, scientific problem solving, and creative product design. The data analysis was done through qualitative descriptive, n-gain, and paired t-test. The results showed (1) student's responsibility for each meeting is in good criteria, and (2) there is a significant increase on students' scientific creativity at α = 5%, with n-gain constitutes moderate category. Thus, the CRBL is believed to be effective to increase student's responsibility and scientific creativity in physics learning.
Keywords: *CRBL, responsibility, scientific creativity*

Meningkatkan Tanggung Jawab dan Kreativitas Ilmiah Siswa melalui *Creative Responsibility Based Learning*

Abstrak

Kreativitas ilmiah dan tanggung jawab diyakini menjadi faktor kunci untuk mengatasi berbagai masalah kehidupan nyata yang semakin kompleks, namun kedua kompetensi tersebut kurang dilatihkan di sekolah. Oleh karena itu, penelitian ini bertujuan untuk mendeskripsikan keefektifan Creative Responsibility Based Learning (CRBL) untuk meningkatkan tanggung jawab dan kreativitas ilmiah siswa dalam pembelajaran fisika di sekolah menengah atas. Penelitian ini menggunakan desain one group pretest and posttest pada 66 siswa dari 2 sekolah menengah atas di Banjarmasin, Kalimantan

Selatan (Indonesia). Pengumpulan data menggunakan instrumen: pengamatan tanggung jawab yang ditekankan pada partisipasi, kerja sama, menyampaikan pendapat, dan kepemimpinan; dan tes kreativitas ilmiah yang ditekankan pada penemuan masalah, peningkatan produk secara teknis, berimajinasi secara ilmiah, pemecahan masalah sains, dan mendesain produk kreatif. Analisis data dilakukan secara deskriptif kualitatif, n-gain, dan paired t-test. Hasil penelitian menunjukkan (1) tanggung jawab siswa pada setiap pertemuan berada dalam kriteria baik; dan (2) kreativitas ilmiah meningkat secara signifikan pada α = 5%, dengan nilai n-gain dalam kriteria sedang. Dengan demikian, CRBL termasuk efektif untuk meningkatkan tanggung jawab dan kreativitas ilmiah siswa dalam pembelajaran fisika.

Kata Kunci: *CRBL, tanggung jawab, kreativitas ilmiah.*

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I. INTRODUCTION

In the Industrial Revolution 4.0, vast development of science and technology has brought human lives with some emerging problems in various fields which are more increasingly complex and diverse [1,2]. For individuals who are not creative, such issues may become challenges as well as threats to survive. Conversely, creative individuals are likely to consider the challenges as the opportunities for self-empowerment to achieve success in life and career. However, creative individuals may lead to the process of creation or destruction of human life. Therefore, scientific creativity learning should be integrated with responsibility attitudes of the students in order to make meaningful learning [3]. Responsibility as self-control is intended to direct their creative products for the common good [4]. For individuals who are creative and responsible, every problem may become an inspiration and imagination to produce useful creative products [5,6]. As part of 21st Century skills, being responsible and having scientific creativity are key factors in the development of science and technology [7-13].

The development of science and technology involves scientific creativity in learning Physics. Physics includes the science of experimental results and the observation of various natural phenomena [1,14,15]. Physics experiments are likely to be more maximum when involving responsibility and scientific creativity when students are accustomed to asking the best questions (worthy of being the target and focus of the experiment), growing their responsibility for the experiment design, and developing possible hypotheses, and being responsible for being able to produce the most accurate and useful creative products [7,8,16]. Physics learning has great potential to create creative and responsible individuals; this is known as creative responsibility.

Creative responsibility means every individual has the responsibility to be creative and direct their creative products for good [8,16].

In fact, the level of thinking skills of the students in Indonesia is considered still low, including their scientific creativity. Students lack of understanding upon the science problems and content, epistemic, and procedural knowledge [17,18]. Students' understanding upon their responsibilities is only limited to conceptual basis, yet into the actualization in real life [8,19,20]. It is confirmed by a study involving several senior high schools in Banjarmasin, Indonesia [18], that the teaching styles employed by the teachers like dominating through lectures and writing on the board have impact to the students' engagement and participation such as only listening and taking notes without being encouraged to enhance their scientific creativity. In addition, students' responsibility in terms of classroom participation, respecting others, cooperation, delivering opinions, and leadership on average is by 63% which is rather good criteria. This can be seen from the students' attitudes which tend to be passive in learning, lack of enthusiasm and concentration when studying, inviting their friends to talk, and showing confusion when they are asked to explain or give question [20]. Thus, students' responsibility and scientific creativity are considered the emerging issues in learning Physics in senior high school level.

One of common creative learning that may integrate students' responsibility and scientific creativity in Physics learning is Creative Responsibility Based Learning (CRBL). CRBL is an innovative learning that is believed to maximize students' responsibility and science process skills in developing their scientific creativity [6,8]. In accordance with John Dewey's problem-solving theory and metacognition theory [21-23], the application of CRBL involves students' responsibility and science process skills in scientific inquiry and real-life problem-solving. Scientific creativity actually has many similarities with creativity in general in terms of fluency, flexibility, and originality. However, this scientific creativity is more emphasized on scientific experiments, finding and solving scientific problems, and creative science activities [24,25].

In the CRBL, students' responsibility and scientific creativity are developed comprehensively in the classroom. It may lead into a m ore effective learning [6,8], which is indicated when students have better understanding upon science problems, ask relevant scientific questions, present creative and imaginative ideas, and improve their responsibility for learning [26,27]. The CRBL requires learning atmosphere which is free, open, democratic, positive, and innovative and involves as many scientific questions as possible, which involves values imaginative products. It is supported by previous research [6,8,20] that the CRBL has been proven to be effective for learning process particularly in higher education. In addition, it is recommended by the researchers the needs for testing the effectiveness of CRBL at various education levels. Therefore, this research intends to examine the effectiveness of CRBL in increasing students' responsibility and scientific creativity in senior high schools.

II. METHOD

Research Design

This research is part of ADDIE's research and development design, namely at the implementation and evaluation stages, which is intended to determine the effectiveness of CRBL in increasing students' responsibility and creativity in senior high schools. The research trial was conducted at Islamic Public Senior High School (MAN) 1 Banjarmasin and one Public Senior High

School (SMAN) 9 Banjarmasin in September-December 2018. The scope of research was eleventh-grade students who were studying fluid material in academic year of 2018/2019. The effectiveness of the CRBL was based on the observations on students' responsibilities during the learning process. This responsibility was stated in the criteria of very good, good, fair, and poor. In addition, the effectiveness was measured from the increase of students' scientific creativity based on pre-test and post-test, as well as the mean n-gain determined by criteria: low, medium, and high.

Research Samples

The population of this study was students in MAN 1 Banjarmasin and SMAN 9 Banjarmasin. Samples were selected through purposive sampling method. The selected samples were Class XI MIA 3 MAN 1 Banjarmasin and Class XI IPA 2 SMAN 9 Banjarmasin which consisted of 32 and 34 students respectively.

Instruments and Procedures

In the previous stage (Analysis, Design, Develop) [21], The CRBL package has been produced and has been validated by three Physics learning experts with validity and reliability values namely: lesson plan (3.46; 0.91), teaching materials (3.35; 0.90), students' worksheet (3.45; 0.89), responsibility observation (3.00; 0.84), and scientific creativity test (3.47; 0.93). It means that the CRBL package meets the criteria of validity and reliability.

In this implementation stage, the research trial employed one group pre-test and post-test design, that is O_1 X O_2. Students worked on pre-test for scientific creativity. It was emphasized on problems finding, product improvement, scientific imagination, science problem solving, and creative product design. Next, the teacher implemented the CRBL in two classes for four meetings (X). The teacher started the lesson by arousing students' creative responsibilities, for instance, the teacher motivated students, explained the learning objectives and the importance of creative responsibility for success in learning. The teacher organized creative learning needs. Students were directed to become creative team and understand laboratory equipment and ICT media to be used. The teacher increased scientific creativity by involving students' responsibility in completing group investigations. After that, the teacher established the creative responsibility of the students by facilitating the scientific creativity tasks and communicating the results. The teacher ended the learning by conducting evaluation and reflection. At the end of the research trial, the teacher asked students to work on the post-test for scientific creativity (O2); the post-test distributed was the same as the pre-test.

In this study, the CRBL was implemented to two classes, namely Class XI MIA 3 MAN 1 Banjarmasin and Class XI IPA 2 SMAN 9 Banjarmasin. Given the limitations of the research time, the responsibility data were only obtained through observing students' responsibilities during the learning process in Class XI MIA 3 MAN 1 Banjarmasin. Students were divided into six groups consisting of 4 to 5 students for each group. Each student in each group was observed by two trained observers. Students' scientific creativity was obtained through pre-test and post-test in Class XI IPA 2 of SMAN 9 Banjarmasin.

Data Analysis

Students' responsibility were analyzed descriptively, namely the average score of responsibility from two observers adjusted to the assessment criteria:

4.00 ≥ very good > 3.50;
3.50 ≥ good > 2.50;
2.50 ≥ fair > 1.50;
1.50 poor > 1.00
(adapted from Kemendikbud [28]).

Data analysis on pre-test and post-test of scientific creativity began by calculating the points of fluency, flexibility, and originality referring to Table 1.

Table 1. Scientific Creativity Assessment Rubric [8, 24]

Indicators	Dimensions	Criteria
1. Problem finding 2. Product improvement 3. Scientific imagination 4. Science problem solving	Fluency	Count all the correct responses given. Every correct response is given point 1.
	Flexibility	Calculate the number of correct approaches given. .
	Originality	Tabulate the frequency of all correct responses obtained. The frequency and percentage of each response is calculated and one of the answers chosen has the smallest probability of response. If the response probability is less than 5%, given point 2; the probability of 5 to 10% is given point 1; and greater than 10% given 0 points.
5. Creative product design	Flexibility	Each function is correctly given point 1.
	Originality	Give a score of 1 to 5 based on a holistic assessment.

The scientific creativity score is the points obtained and divided by maximum points multiplied by 100, where the maximum points are the highest points obtained by students in that class. Furthermore, the level of increase in students' scientific creativity is calculated using n-gain (Hake, 1998). The choice of the test method relied on the fulfilment of normality assumptions for the scores of the pre-test and post-test of the students' scientific creativity. Whether or not an increase in scientific creativity was tested statistically with paired t-test (parametric) or Wilcoxon test (non-parametric). This test was done with the help of IBM SPSS 16.0 software.

III. RESULTS AND DISCUSSION

Student's Responsibility

The responsibility data were obtained from observations on the students' responsibility during the implementation of the CRBL. The results of the analysis of responsibility are presented in Table 2.

Table 2 elaborates the results of the observation on the students' responsibility for each group. When CRBL was applied for four meetings, students were able to express opinions, actively participate, lead, and work well together within the group members. The average score of student responsibility in each meeting is presented in Figure 1.

Figure 2 shows the average post-test score on each indicator of scientific creativity; overall, the average score during the post-test is higher than the average score during the pre-test. In terms of the mean score of pre-test and post-test, as well as the n-gain scores of scientific creativity, are presented in Table 3.

Table 2. Results of Observation on Students' Responsibility in the Six Groups

Groups	Indicators of Responsibility	Meetings			
		I	II	III	IV
I	Delivering opinion	2.8 (G)	3.3 (G)	3.4 (G)	3.5 (G)
	Participatory	3.3 (G)	3.3 (G)	3.4 (G)	3.4 (G)
	Leadership	3.1 (G)	3.2 (G)	3.4 (G)	3.3 (G)
	Cooperation	2.8 (G)	3.3 (G)	3.2 (G)	3.4 (G)
II	Delivering opinion	2.7 (G)	3.3 (G)	3.3 (G)	3.3 (G)
	Participatory	3.6 (VG)	3.2 (G)	3.3 (G)	3.3 (G)
	Leadership	3.0 (G)	3.2 (G)	3.3 (G)	3.3 (G)
	Cooperation	3.0 (G)	3.1 (G)	3.2 (G)	3.3 (G)
/III	Delivering opinion	2.9 (G)	3.3 (G)	3.4 (G)	3.5 (G)
	Participatory	3.5 (G)	3.2 (G)	3.3 (G)	3.4 (G)
	Leadership	3.1 (G)	3.2 (G)	3.3 (G)	3.3 (G)
	Cooperation	3.3 (G)	3.1 (G)	3.3 (G)	3.3 (G)
IV	Delivering opinion	2.8 (G)	3.3 (G)	3.1 (G)	3.3 (G)
	Participatory	3.5 (G)	3.1 (G)	3.1 (G)	3.4 (G)
	Leadership	3.4 (G)	3.4 (G)	3.0 (G)	3.1 (G)
	Cooperation	3.0 (G)	3.4 (G)	3.0 (G)	3.1 (G)
V	Delivering opinion	2.7 (G)	3.0 (G)	3.2 (G)	3.3 (G)
	Participatory	3.6 (VG)	3.0 (G)	3.2 (G)	3.4 (G)
	Leadership	3.1 (G)	3.0 (G)	3.1 (G)	3.2 (G)
	Cooperation	2.9 (G)	3.2 (G)	3.1 (G)	3.1 (G)
VI	Delivering opinion	2.6 (G)	3.1 (G)	3.3 (G)	3.4 (G)
	Participatory	3.4 (G)	3.1 (G)	3.3 (G)	3.3 (G)
	Leadership	3.2 (G)	3.2 (G)	3.3 (G)	3.1 (G)
	Cooperation	3.1 (G)	3.2 (G)	3.3 (G)	3.0 (G)

Description: Range of scores 1 - 4; G = Good, VG = Very Good

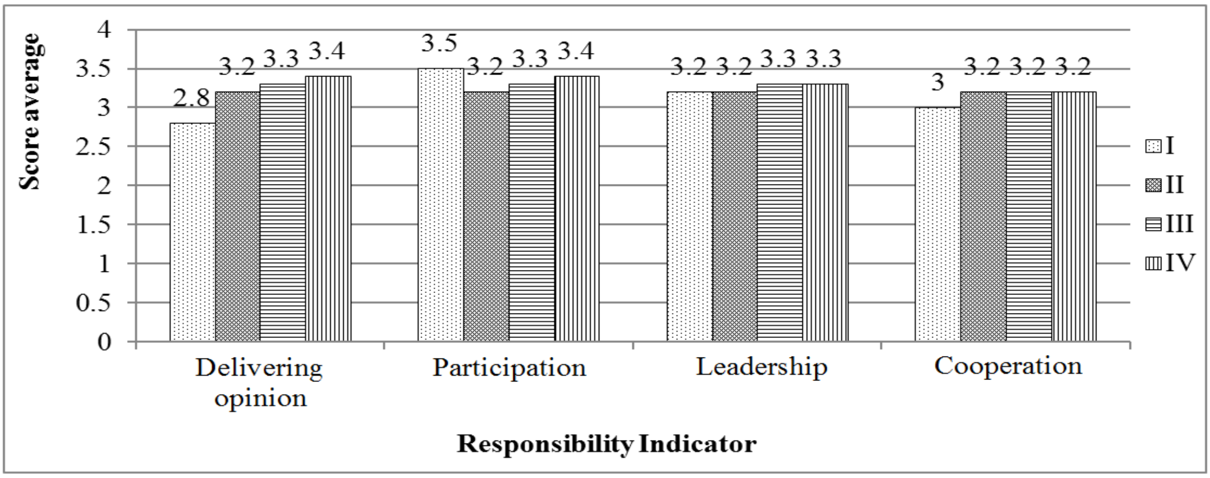

Figure 1. Value of Indicators of Responsibility

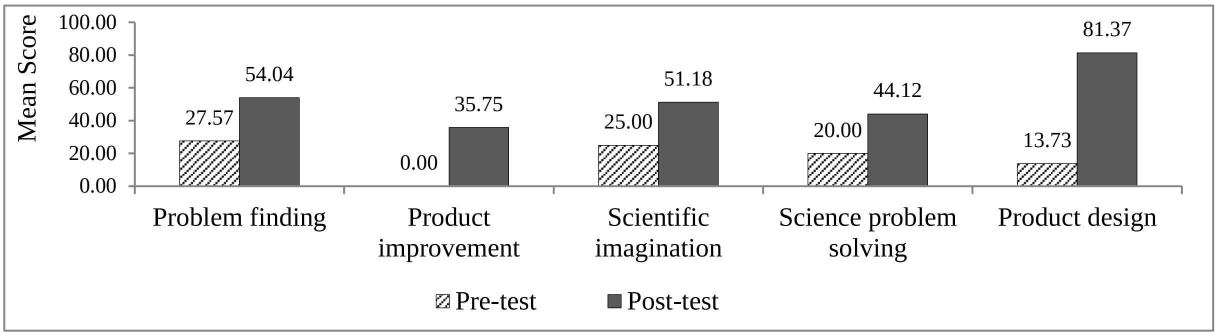

Figure 2. Value of Indicators of Scientific Creativity

Table 3. Results of Pretest, Posttest, and N-Gain of Scientific Creativity

Pretest	*Posttest*	*N-Gain*	
		<g>	Criteria
22.80	64.52	0.54	Moderate

Based on Table 3, the average score of pre-test of scientific creativity is 22.80; it means that students are not initially familiar with the indicators of scientific creativity which include problem finding, product improvement, scientific imagination, science problem-solving, and creative product design. On the contrary, after the CRBL was implemented in the classroom, it was observed that the average score of students' scientific creativity increased to 64.52. However, the score during post-test (Figure 2) for problem finding, product improvement, scientific imagination, and scientific problem solving is lower than the Minimum Resolution Criteria (MCC = 60). Students have understood scientific creativity well. However, students are considered to lack of actualizing their scientific creativity in learning new Physics material, especially in the efforts to relate with real life. The low knowledge of Physics makes it difficult for the students to actualize scientific creativity in Physics learning. Discussed in previous research [7] that in terms of initial knowledge, including raw materials for creative activities, students may be given exemplary in being creative, never giving up, and not despairing at work. Scientific knowledge has a significant effect on students' scientific creativity [3,23,29,30,31].

Another reason is time constraints in which that the CRBL was implemented only for four meetings. The findings in this study are different from previous research [8] that CRBL was able to increase the scientific creativity of students with a value of above the MCC. The reason is that the students had previously been provided with science process skills for two meetings and followed with CRBL for six meetings. Therefore, the development of scientific creativity requires perseverance and long-term commitment [7]. Although students' scientific creativity is lower than MCC, the n-gain scientific creativity is 0.54; it means that the implementation of CRBL is able to increase students' scientific creativity in fair criteria. The teacher has prepared learning tools and conducive learning environment, as well as facilitating social interactions to construct scientific creativity [6,8].

Furthermore, the significance of CRBL on students' scientific creativity is determined through statistical tests. This test began with a normality test on the data of pre-test and post-test of the scientific creativity using the Kolmogorov Smirnov test, and the sig value obtained is 0.86 and 0.20; it means that data of the pre-test and post-test are normally distributed. Therefore, a statistically different test was performed with the Paired Samples Test with IBM SPSS 16.0 software. The test results are presented in Table 4.

Table 4. Results of Paired Samples T-Test of Scientific Creativity

Pair Pretest-Posttest of Scientific Creativity	Paired Differences			T	df	Sig.
	Mean	Std. Deviation	Std. Error Mean			
	-0.42	16.14	2.77	-15.07	33	0.00

Table 4 shows that the score is significant because $p < 0.05$. Since the results of the calculations are negative, Table 4 shows that the average of scientific creativity is 16.14 and has degrees of freedom (*df*) = 33, *t* score gives *t* value = -15.07, the score is significant because $p < 0.05$. It is clear that there is an increase in scientific creativity after the application of learning with CRBL in the Physics learning.

Based on research findings, it can be synthesized that CRBL has significant impact on increasing students' responsibility and scientific creativity in Physics learning. During the learning process, the teacher involved students' responsibility and process skills in scientific investigations and scientific creativity tasks. Students are accustomed to asking the best questions, fostering students' responsibility in carrying out experiments creatively, and developing possible hypotheses, and taking their responsibility for producing useful creative products [6,8]. The actualizing responsibility and scientific creativity comprehensively in the classroom makes the Physics learning more effective, meaningful, and active [7,8,16]. The limitations of this study are related to the data on responsibility and scientific creativity obtained from different classes, so correlation between the two classes is not observed adequately. In addition, the low provision of initial Physics materials given to the students and time constraints have impact on the score of post-test of the scientific creativity which is still less than the MCC. Therefore, when educators plan to implement CRBL, they need to check the initial provision of physics content and learning implementation for a minimum of 6 meetings. However, Tables 3 and 4 show that CRBL is effective to increase the students' scientific creativity of senior high schools in the fair category.

The fundamental implication of this research is that the implementation of CRBL in the secondary schools is believed to produce individuals who are creative and responsible, namely individuals who have a responsibility to be creative and direct their creative products for the common good. Students are not only prepared to be creative and scientific individuals, but also individuals who are responsible in real life [8]. Thus, when CRBL is applied on a large scale in high school, teachers are able to prepare students as creators, innovators, collaborators, and communicators who are able to make creative products that are useful for society and the environment. Students are prepared for success in their lives and future careers.

IV. CONCLUSION

The implementation of CRBL is effective to increase students' responsibility and scientific creativity in senior high schools, particularly for fluid material in Physics lesson. This effectiveness is based on the following findings, namely (1) students' good responsibilities at each meeting, and (2) significant increase of students' scientific creativity, the n-gain of scientific creativity in moderate criteria. Thus, CRBL is believed to improve students' responsibility and process skills in developing their scientific creativity.

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